the Cornell

engineer

MARCH, 1961
VOL. 26, NO. 6
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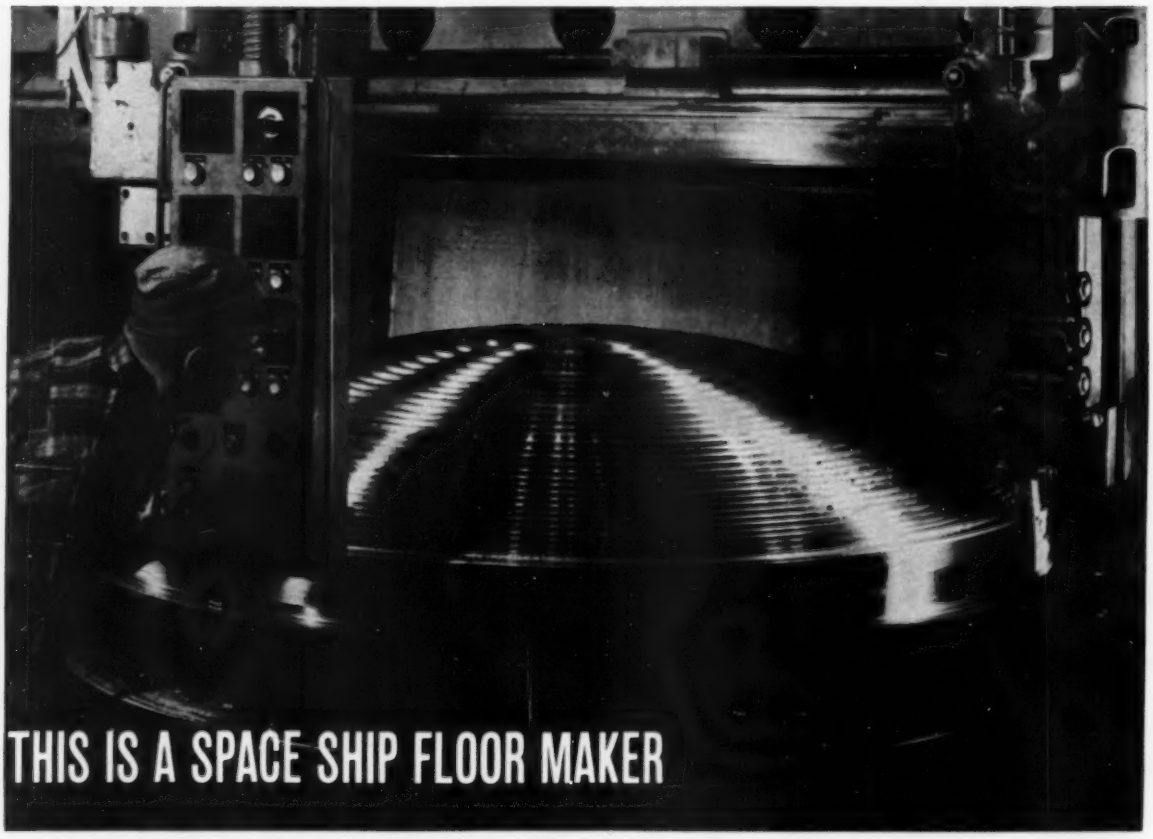

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COVER designed by Mary Ann Huber, CE '63, represents radioactive wastes ready for disposal. For story on radioactive waste disposal, please see page 13.

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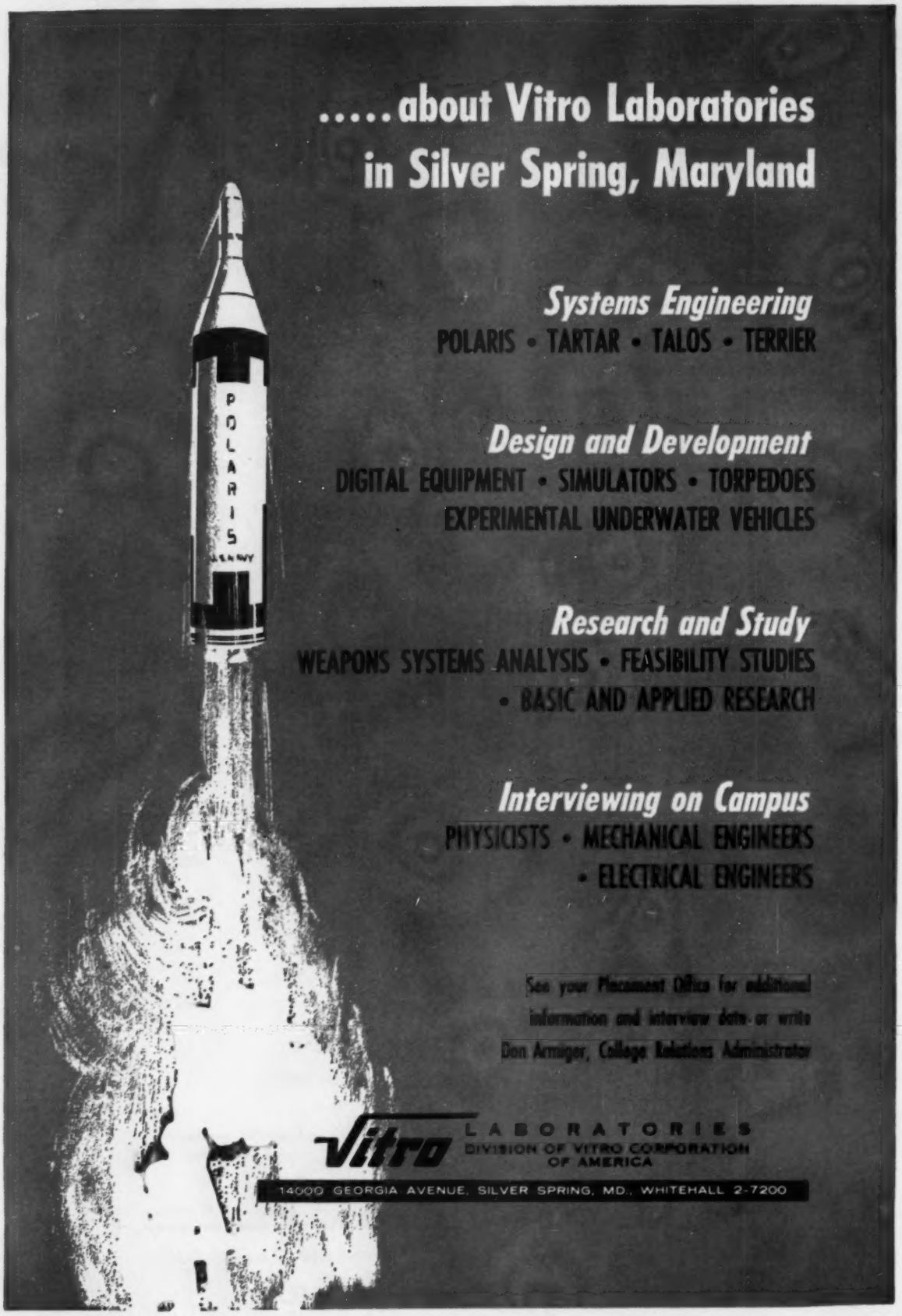

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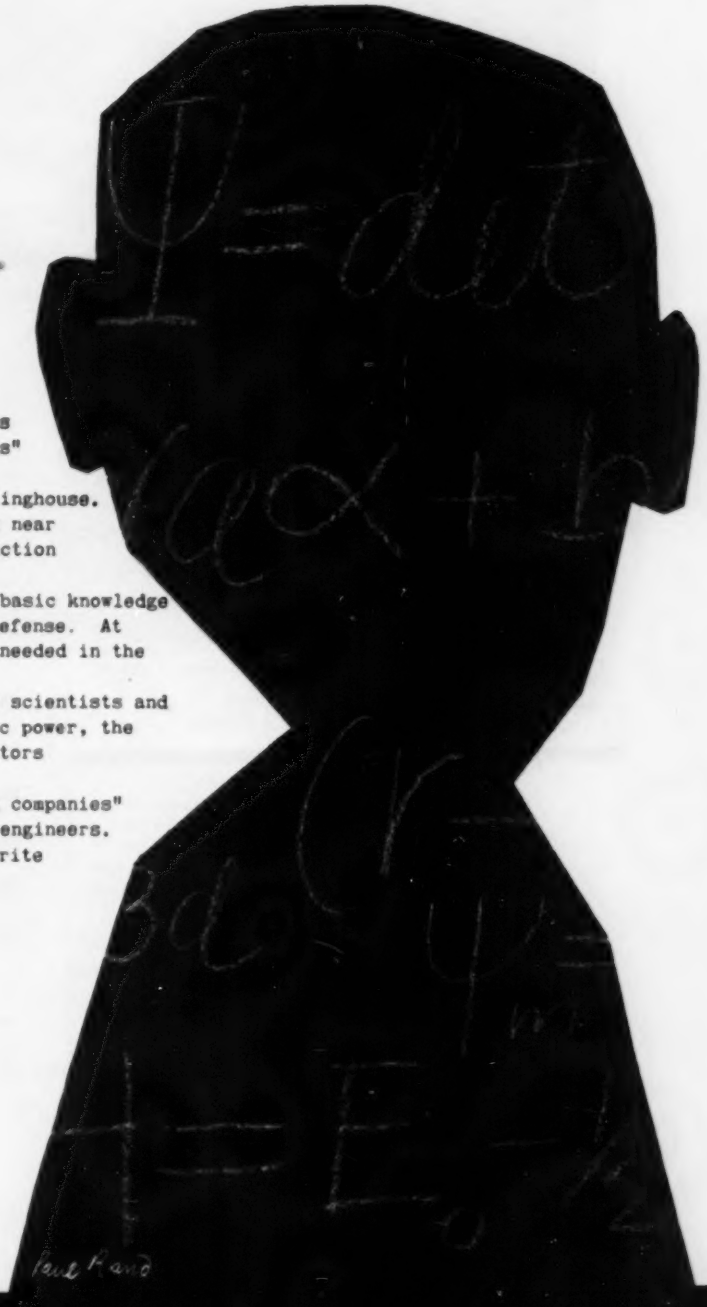

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NASA program-highlights

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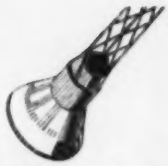

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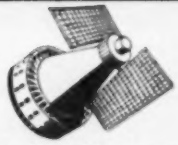
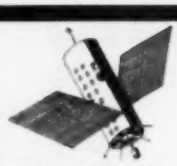


Nimbus—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.



Orbiting Geophysical Observatory—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.

Project Aeros—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.

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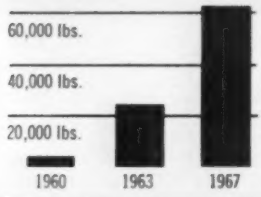
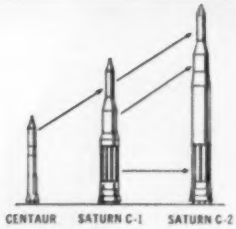


Anticipated Growth of NASA Spacecraft in terms of weight of individual near earth satellites.



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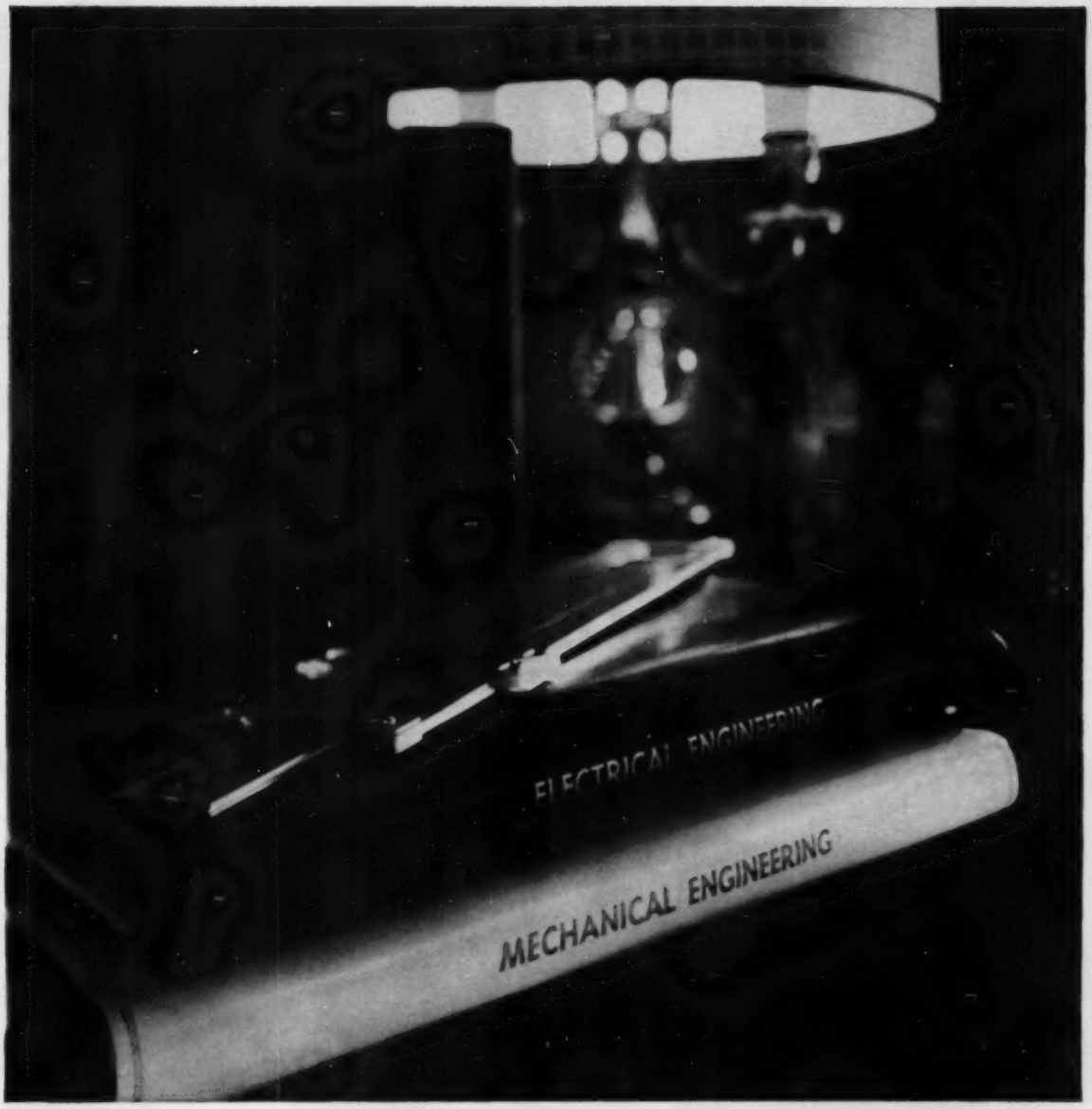

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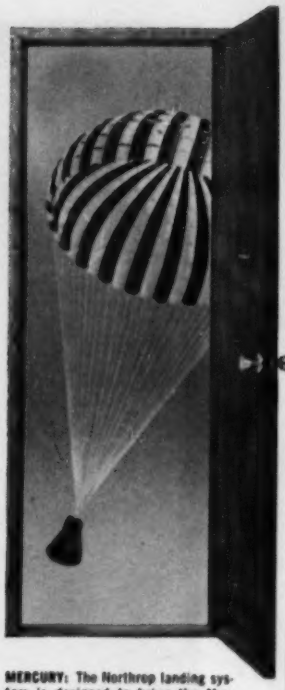

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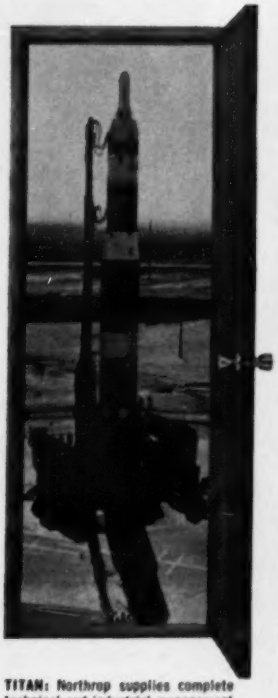

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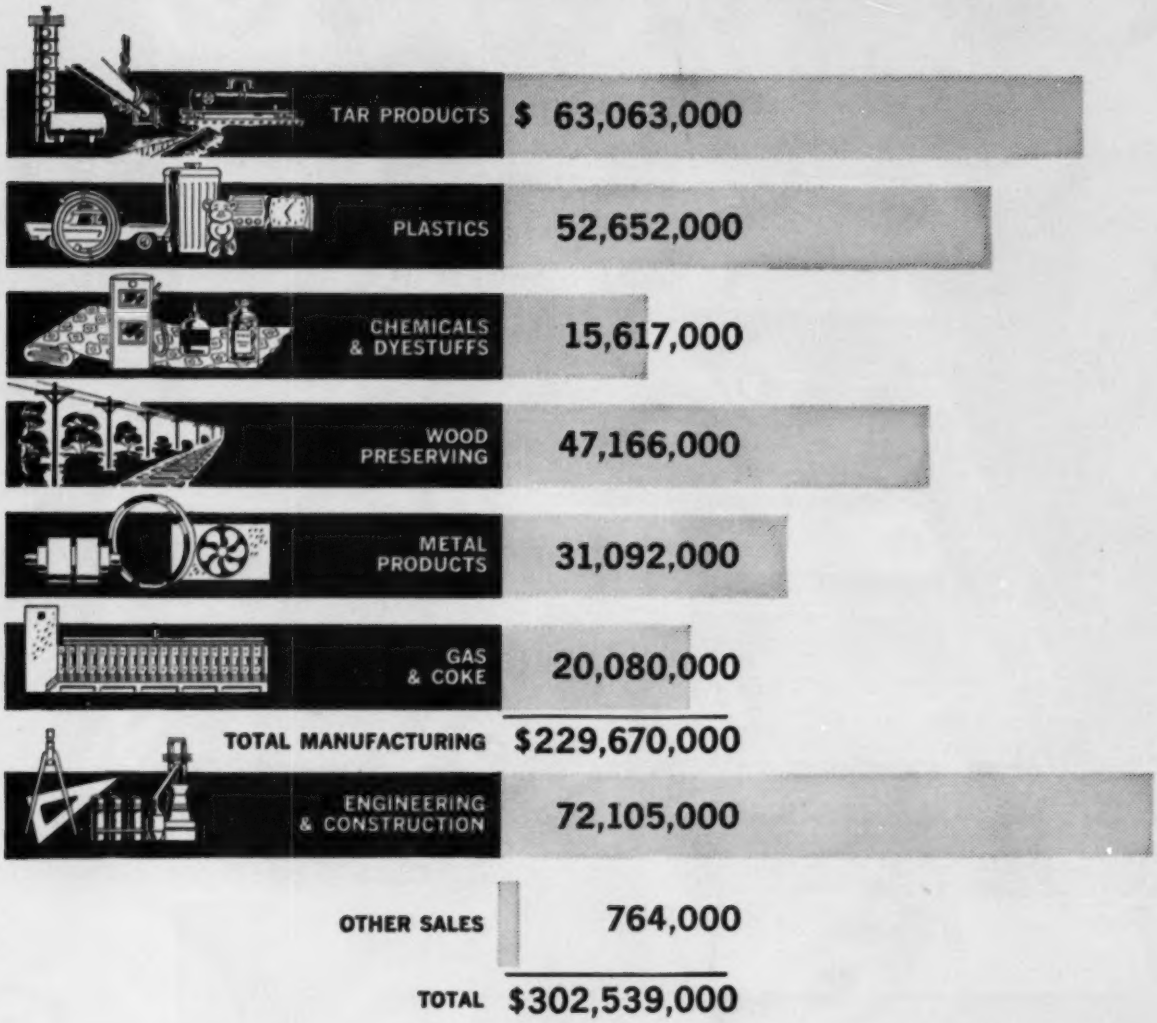

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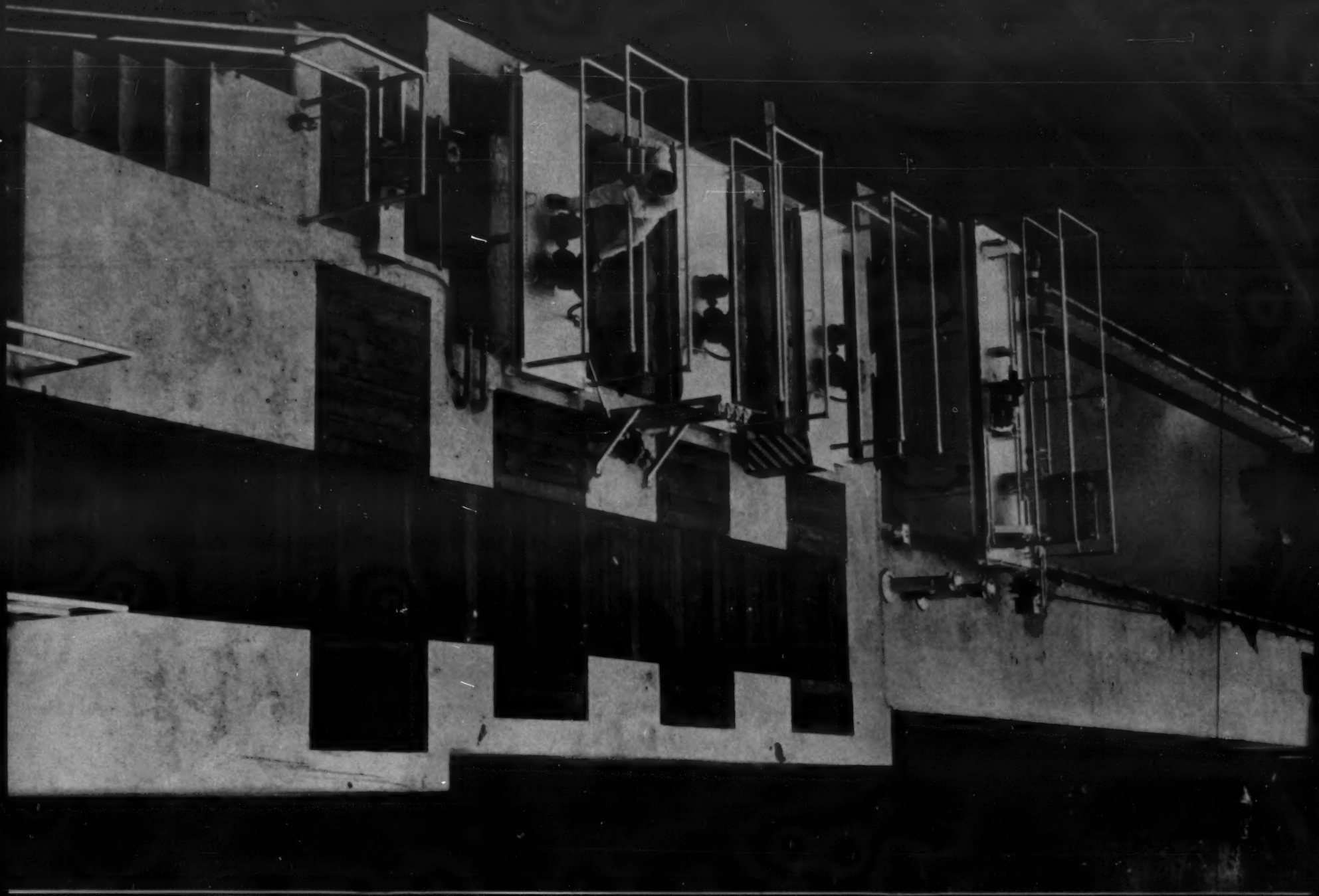


RADIOACTIVE WASTE DISPOSAL

by Stanley Schlozman, ME '65

Radioactive waste disposal is fast becoming a key problem in today's rapidly growing atomic energy industry. Radioactive wastes cannot be treated in the same manner as other industrial wastes, for discharged radioactive material may contaminate air or drinking water, and may cause biological damage if absorbed by an organism. Because of this great biological danger, the National Committee on Radiation Protection has established a list of the maximum permissible concentrations of radioisotopes in different media, so that overexposure to these wastes can be prevented. Systems for the disposal of radioactive waste must therefore be designed so that these tolerance values are never exceeded.

Solid Wastes

Solid wastes consist primarily of incidental material which has become contaminated during the course of normal operations. These solid wastes may be classified as combustible or non-combustible.

Combustible wastes, including paper, clothes, filters, and wood, are often concentrated by burning in special incinerators. Through the use of scrubbers and filters, these incinerators remove the radioactivity from the combusion gases and do not allow any radioactive material to pass into the atmosphere. The resultant ash is disposed of in the ordinary manner, such as burial or sea dumping. Such incineration affords a 60 per cent saving of valuable storage space.[1]

The noncombustible solid wastes are either enclosed in barrels or concrete blocks and dumped in certain parts of the ocean, or they are buried in selected locations on the land.

Gaseous wastes such as radioactive isotopes of the inert gases krypton, xenon, and argon, and the volatile fission products iodine and ruthenium, are given off during the reprocessing of spent reactor fuel elements and in the incineration of solid wastes. Water scrubbers, charcoal or silica gel adsorbers, and filters are used to decontaminate these gases before their dispersal to the atmosphere through tall discharge stacks.

A large portion of the airborne radioactive waste comes from reactors which are cooled by gas which is subsequently released to the atmosphere. The radioactivity in the discharged gas can result from the irradiation of dust particles in the air, the pick-up of radioactive particles of concrete and graphite from the inner surface of the reactor, and from radioactive particles released from a ruptured fuel can. In order to reduce the amount of radioactivity escaping from gas-cooled reactors, the number of dust particles in the air entering these reactors is reduced by filtration. In addition, most of the radioactive particles leaving the reactor are filtered out before the air is discharged into the atmosphere.

All of the large atomic energy establishments which discharge significant amounts of radioactive gases to the atmosphere employ meteorological staffs to determine the occasional combination of bad weather conditions which might retard the normal dispersion of slightly radioactive gases. Ordinarily, the gases dissipate with no harmful effects; however, adverse weather conditions could cause the gases to settle and concentrate in one area.

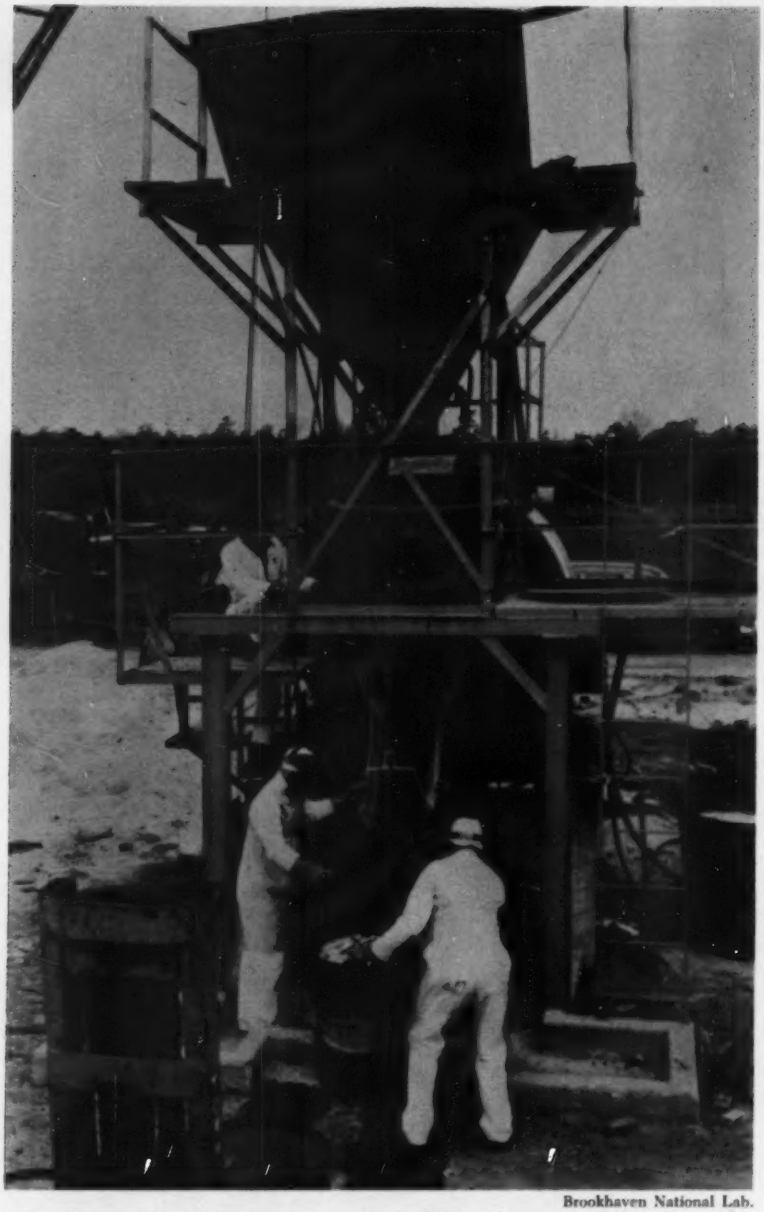
Liquid Wastes

Most of the radioactive waste being produced today is in the liquid state. For purposes of disposal, this waste is often divided into low level, intermediate level, and high level activity waste.

Low level radioactive wastes are produced in fuel reprocessing plants, varied operations of large atomic energy laboratories, and atomic reactor cooling water. Because this type of waste is present in large volumes and contains only small concentrations of radioactive material, disposal to the natural environment (i.e. the ground, streams, and seas) seems most practical. However, the degree of treatment of large amounts of low level waste and the amount of material discharged directly to the environment must be very carefully controlled, for fish and vegetation selectively absorb these materials and often greatly concentrate the radioactivity.

Oak Ridge National Lab.

A view of the process waste treatment plant at Oak Ridge, Tennessee.



Brookhaven National Lab.

Barrels containing radioactive wastes are shielded with concrete before disposal.

Low level wastes are usually held in storage ponds or basins for short periods before release to allow for the decay of some activity. During this time they are extensively monitored. As a result, batches found containing abnormal amounts of radioactivity are placed in higher activity level disposal systems.

The British have made the most extensive use of direct sea disposal of low level waste. The United Kingdom Atomic Energy Authority has built all of its chemical processing plants on the sea coast so that waste material can be discharged. They now have three pipelines into the sea carrying waste to be diluted.

Intermediate level wastes generally arise from the later stages of chemical reprocessing of spent fuel elements and in the scrubbing of off-gases from fuel dissolution. In the United States these intermediate wastes are usually discharged to the ground after some pretreatment. The Oak Ridge National Laboratory, for example, carries on a modified soda ash process of the type commonly used in water softening, which removes up to 87% of the total radioactivity in a single pass through the treatment plant.

The purification of discharged waste is accomplished as it passes through the soil. There a high percentage of the radioactive material is removed, and the decontaminated material passes on to become part of the normal ground water system.[2] "The role of clays, shales, and weathered rocks is a very important one in this method of disposal where the essential mechanism is ion-exchange of the soil particles."[3]

The capacity of the soil to trap radioactive materials and hold them for a long time must be determined prior to their direct disposal. The disposal process itself is usually carried out through underground cribworks and open seepage basins. Careful monitoring is always an integral part of these disposal operations, for these monitorings determine the extent and rate of movement of the radioactive material through the soil.

Wastes of intermediate level are sometimes mixed in concrete and solidified, or packaged in steel drums. The concrete blocks or drums are then dumped into specified areas of the ocean. Thus the activity is contained until the drum or concrete disintegrates. Substantial decay of the radioactivity occurs before the dispersal of the contents takes place, and any small leakage before this time is assumed to be greatly diluted. The method of sea disposal is presently under great criticism and much more work by oceanographers is needed to gain information about ocean currents and the rate at which radioactive substances at the bottom of the ocean mix with the surface waters.

High Level Wastes

High level atomic waste refers to the waste streams emerging directly from the reprocessing of atomic reactor fuels. Virtually all of these wastes are in the form of aqueous solutions.

Ocean disposal of these high level wastes is practiced, but it is most attractive to countries with limited land area and dense population. In the United States the high

activity waste is stored in underground tanks made of steel and concrete. Many of these tanks are equipped with cooling coils in order to remove the decay heat of fission products. Aging for several years is required before the activity decays to a point where cooling is no longer needed.

At the present time over 65 million gallons of high level liquid wastes are stored in underground tanks in the United States, primarily at Hanford, the Savannah River Plant, and the National Reactor Testing Station in Idaho. Because the life-expectancy of the present tanks may be only a fraction of the hazard-life of radioactive material they may contain, several methods for ultimate disposal are being studied.

The primary methods now under consideration are:

"1. Storage in cavities in natural salt formations.
2. Injection through wells into permeable formations in which natural conditions would provide storage space and prevent migration of the wastes.
3. Deep well injection into impermeable formations after they have been fractured by hydrostatic pressure to form storage spaces for a slurry containing the waste liquids.
4. Concentration and fixation into a stable solid such as a ceramic or glass and storage or burial in selected locations.
5. Calcination and storage."[4]

Of these, disposal in salt formations, fixation in solids, and calcination are the most promising for early development.

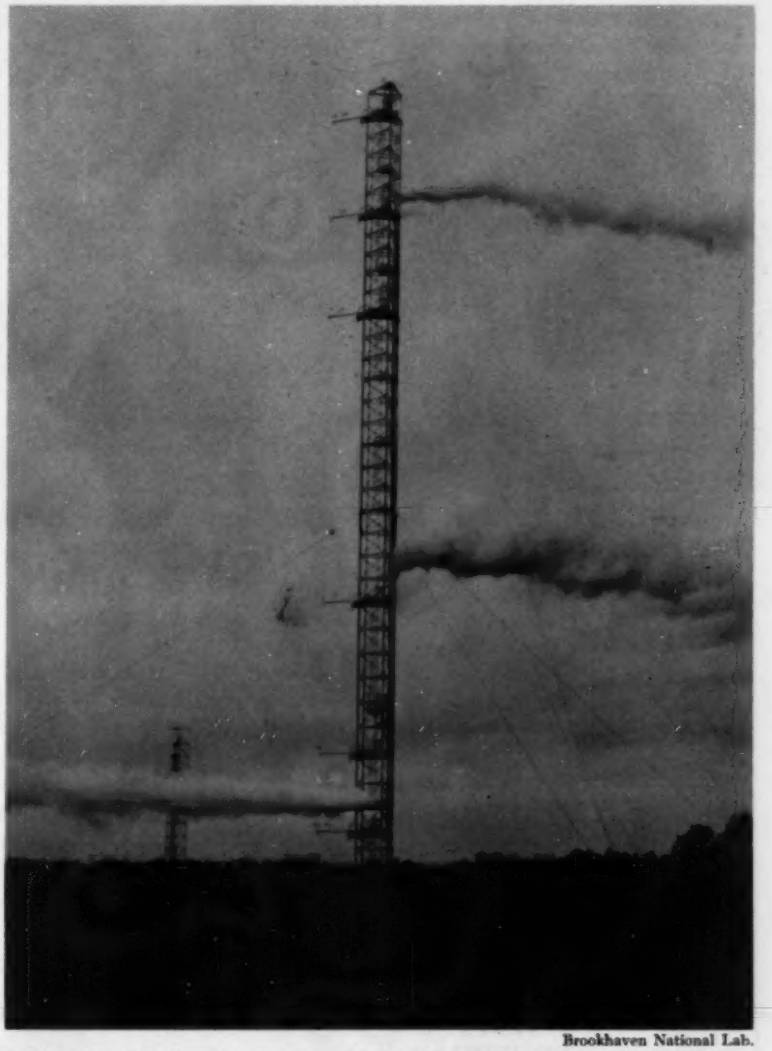
Fixation and Calcination

Considerable effort is now being put into the investigation of methods of converting liquid wastes to solids, for solids seem to be safer to store than liquids and represent the minimum storage volume. For these reasons, the conversion of liquid radioactive waste into a solid inert form and the subsequent long-term storage of these solids in a specially selected geologic formation is considered an excellent solution to the problem of ultimate waste disposal.

There are many ways in which radioactive isotopes may be combined with solid substances for disposal. Work is going on in various laboratories all over the world on the fixation of radioactive materials in glasses, soil minerals, feldspars, alumina, and silica; and the fusion of these isotopes into glasses, glazes, and clays.

Brookhaven National Laboratory, for instance, is developing a fixation process involving one or more pretreatment steps followed by the adsorption and fixation of fission products in montmorillonite clay. The pretreatment steps remove or neutralize the bulk salts or acids in the wastes so that the adsorption of fission products on the clay proceeds more efficiently.[5]

The calcination process involves the conversion of the bulk metal salts (aluminum nitrate, zirconium fluoride, and aluminum fluoride) used in fuel reprocessing into their stable oxides by thermal decomposition and steam hydrolysis. After a preliminary leaching, these solids are suitable for burial. During the process less than 0.1 per cent of the feed activity other than



Brookhaven National Lab.

A "smoke run" at Brookhaven National Laboratory, Upton, N.Y., graphically illustrating the point that wind currents can move independently in separate layers, and even in opposite directions.

Analyses of such data enable meteorologists to determine the occasional combination of adverse weather circumstances which might conceivably retard normal dispersion at high altitude of air which has been used to cool the Brookhaven nuclear reactor, or atomic pile. When such circumstances arise, the meteorologists telephone reactor operators so that the reactor can be shut down until weather conditions improve.

ruthenium appears in the overhead condensate. Furthermore, the volume reduction accomplished ranges from six to ten times.

Disposal in Salt Cavities

If the world's nuclear power industry continues to expand at a rapid rate, the volumes of waste produced will soon be tremendous. Therefore, an extremely cheap and safe method of storing radioactive wastes will be needed. Many now think that this can be done by storing the wastes in underground salt formations.

The petroleum industry has been storing liquified petroleum gases economically and safely in cavities of salt formations since 1950. If the disposal of radioactive wastes in salt proves equally successful, then one of the most troublesome problems in the nuclear power industry will be solved.

Salt's comparatively high thermal conductivity and melting point make it favorable for the storage of high level radioactive waste. Many salt cavities of 10 to 100 million gallon capacity have been constructed for only a few cents per stored gallon. This contrasts favorably with the present cost of a few dollars per gallon for the storage of high level waste.

Under compressive stress salt is impervious to the passage of gases and liquids. Salt is also plastic and therefore undergoes plastic flow without cracking when subjected to certain shearing stresses. It therefore acts as a self-sealer of the storage cavity.[6] A great deal of research and development is presently being conducted in this field in the hope that storage in salt cavities will provide an adequate solution to the question of ultimate disposal.

In the meantime, radioactive waste disposal remains a problem of acute national and world interest. The waste dispersed into the atmosphere affects all the world and the waste dumped into the sea affects those countries bordering the oceans and those people who consume food from the sea. We must therefore continue our search for safe means of radioactive waste disposal and continue to guard against any excess or unnecessary exposure to these wastes.

FOOTNOTES

[1] K. Saddington and W. L. Templeton, *Disposal of Radioactive Waste*, (London, 1958), p. 67.

[2] L. P. Hatch, "Ultimate Disposal of Liquid Wastes," in *Sixth International Congress and Exhibition of Electronics and Atomic Energy* (United States Atomic Energy Commission, 1959), p. 18.

[3] *Ibid.*, p. 18.

[4] *Reactor Fuel Reprocessing*, (Argonne National Laboratory, June 1960), p. 69.

[5] Hatch, *op. cit.*, p. 18.

[6] *Ibid.*, p. 20.

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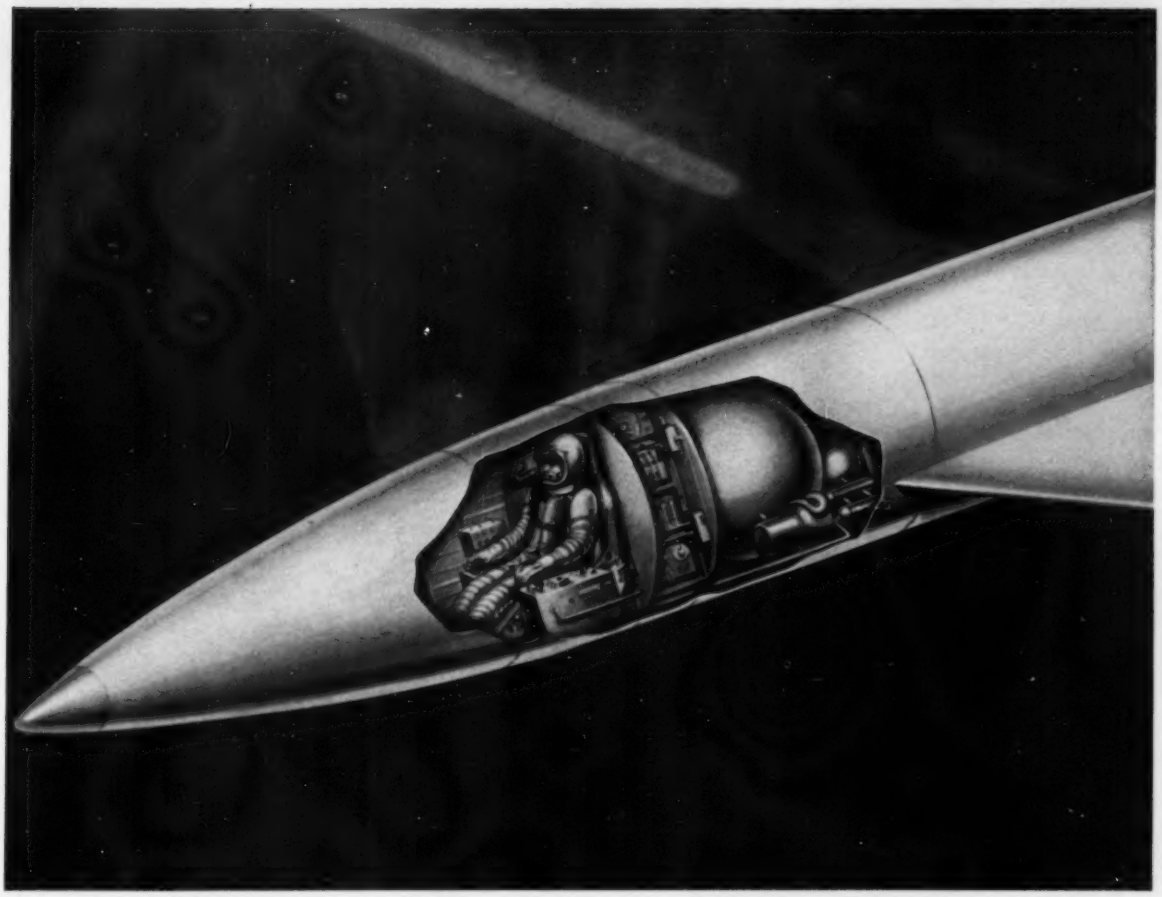

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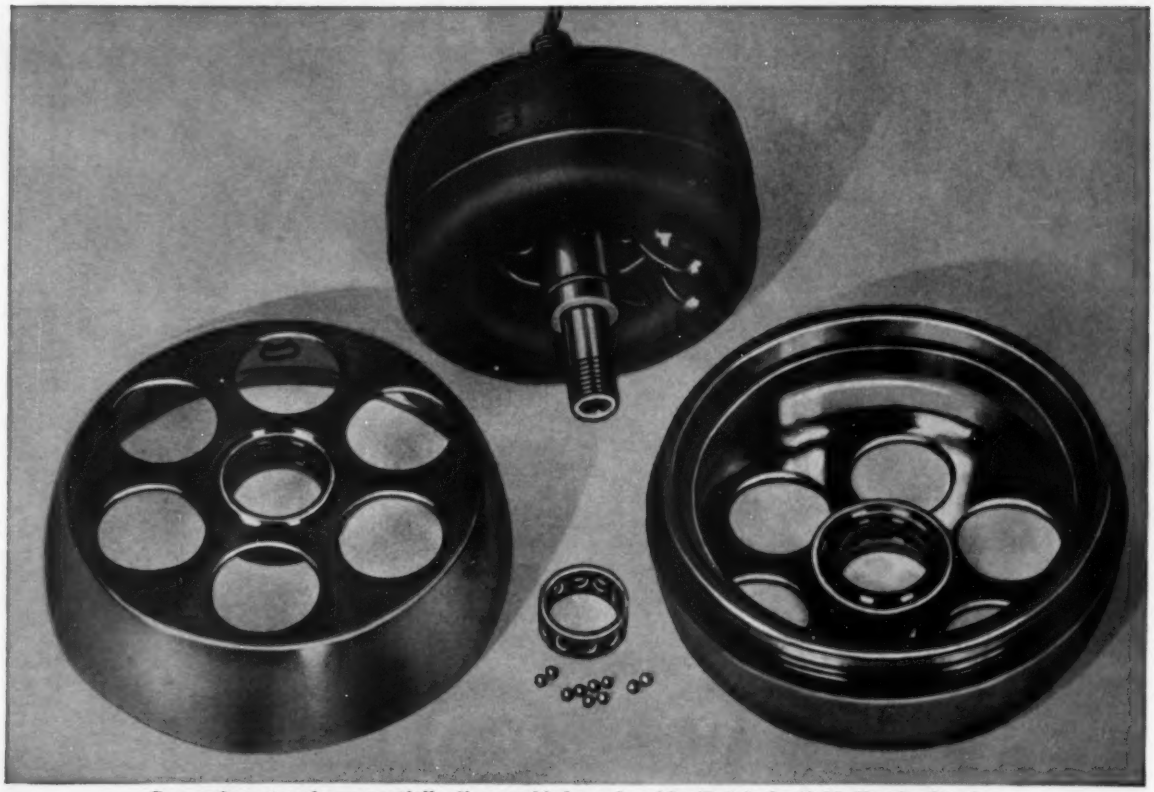

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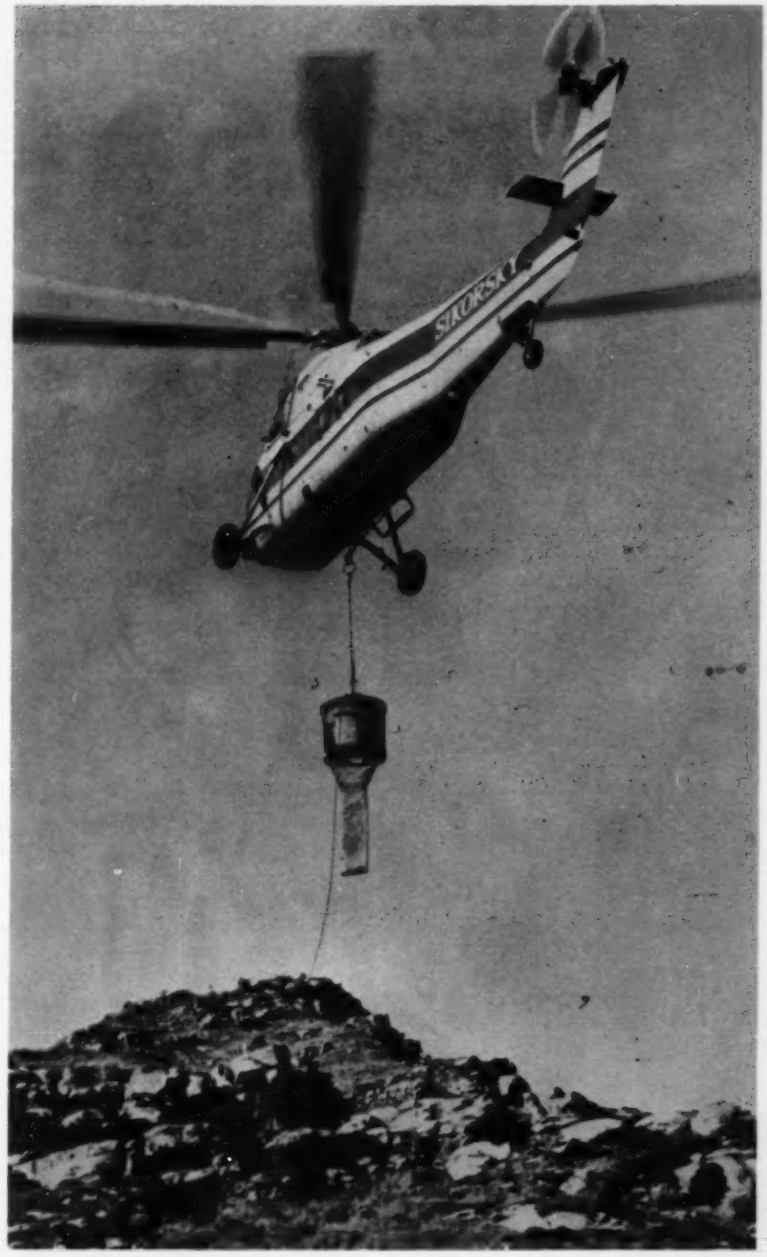
INDUSTRY FINDS NEW USES FOR HELICOPTERS

by Theodore Spar, CE '62

The construction industry has been receiving a new lift recently from the helicopter. Its unique advantages over conventional means of man and material transportation portend an era of increased mobility for an industry marked by heavy, slow moving equipment. Many construction operations are preceded by a long, unproductive period devoted to the building of haul roads, stock yards, and other facilities which will be unnecessary when the project is completed. These expensive auxiliary operations are needed to allow a smooth flow of men and equipment to the job site. The helicopter's mobility and usefulness as a transportation device are making it possible to by-pass these operations. As an aid to field construction, these crafts can save time and money on any engineering project.

These new found tasks are being handled by small companies made up of expert pilots who specialize in flying their copters plus the heavy loads into areas where they are needed. Expert skill is required of these men who, many times, are called on to make deliveries not to a broad field but to a final location site where placement must be made within a few inches.



Sikorsky Aircraft

The S-58 picks up a loaded concrete bucket and flies over mountainous terrain to construction site.

Flying in Oil Derricks

The petroleum industry turned to the helicopter to aid in the search for oil in rugged terrain. A typical project would be reconnaissance by a low flying craft, capable of slow flight, hovering over prospective areas. Seismic and survey parties are easily and quickly flown into interior jungle sections or mountainous regions. Parties can be moved rapidly from one area to another by helicopter with terrain providing a minimum of interference. If the area appears to be promising enough to venture sinking a well, the helicopter provides economic as well as speed advantages.

At best, oil well drilling is financially risky; costs must be kept to a minimum because of the strong possibility that the well will prove dry. In the mountainous and jungle sections where world needs are now pushing the search for oil, haul roads are both time-consuming and costly ventures. On a recent job in the Netherlands New Guinea, two helicopters moved supplies from a base camp, over sixteen miles of dense jungle, to a well site in six weeks. Company officials estimated that conventional methods of building haul roads and trucking in equipment would have consumed fifteen months of valuable working time. The craft flew in all material necessary for the construction and operation of the site.

First on a typical schedule for this type of job would probably be a bulldozer and ground clearing crew. Flown in section by section due to its weight, the "dozer" would be assembled on the site and put to work clearing a suitable area for the rig. Next, the helicopter will fly in the entire drilling rig, also in sections. As a consequence of the use of helicopters for flying in equipment, oil companies are now striving to produce lighter weight materials that will necessitate fewer flying trips. Many instances have been reported in which a helicopter has been able to serve two rig sites at the same time, bringing in equipment faster than it is needed. In any such operation, careful planning is necessary to insure the continuous operation of the craft. This includes proper labelling of loads with destination and weight, and the layout of material in a stockyard in such a manner as to promote easy pick-up. The most difficult task for a helicopter in setting up a drill rig is the carrying of long lengths of pipe which may rotate in flight, causing stability control problems. Another difficulty reported by many pilots is a phenomenon known as "air resonance." Due to an unfavorable combination of forward speed, load size, and load position, violent vibrations and rollings sometimes build up. Although the causes of air resonance are not yet fully understood it is felt that stability is lost due to too great a lowering of the craft's center of gravity. Short of jettisoning the load, a speedy change of power settings is the accepted method of restoring control.

All equipment delivered to the site can, if a proper flight schedule has been followed, be positioned within a few inches of its final location. The drill mounts themselves are held in position by the helicopter until temporary supports are in place. Once a site is fully equipped, the helicopter will make periodic trips to bring in supplies or exchange personnel. In rough country, the savings over conventional means of transportation are so great that one early helicopter-built dry well was termed a "successful failure" by its owner because of the advent of the new era which it proclaimed.

Erection of Overhead Transmission Towers

Perhaps more dramatic is the role of the helicopter in power line construction. Pioneer work in this field was done in Puerto Rico, a country of rugged land sorely in need of rural electrification. Here, using a single Sikorsky S-58, poles were transported and placed at the rate of 100 per day. Previous methods would have required three to four months to install this amount, and would have used a much larger work force. Crews were first leap-frogged from one pole site to the next to dig the required holes. Then the poles were flown in and positioned from the air. In some cases, the pole was only a single vertical timber, but even if the schedule called for a pole and cross arms to be flown in as a single unit, the work proceeded rapidly.

Recently, work had been done in the United States to study the feasibility of installing high voltage electric power transmission lines by helicopter. Larger poles, consisting of two vertical members with cross arms and truss bracing are being flown to predug holes in one unit. Stringing of the conductor is done directly from the helicopter, which draws the line off a spool on the ground and places it across each cross arm. Final connections and tensioning are done by ground crews. The American Electric Power Company, sponsors of the project, expect total construction time to be one third less than conventional methods. Three other experimental projects involving helicopters and power line construction are also being studied by the AEP System. They are the hauling of pre-assembled steel towers, the setting of a complete aluminum tower, and the field erection of a steel tower by helicopter. If these methods prove successful they will allow for even greater use of the helicopter in this field.

The Versatile Helicopter Aids Many Types of Industry

Surveying parties are taking advantage of the helicopter as a valuable time saver on many varied projects. An intriguing example is in the field of hydrographic surveys; surveys to map the bottoms of bodies of water. In one project, the helicopter hovered over the water surface, its elevation kept constant by signals from a level-man on a nearby bluff. At the moment a sounding was to be taken, as indicated by a signal from a flagman on the craft, its position as an angle from a baseline was noted by two transits set up a known distance apart on the baseline. Thus the location of the point and its depth are uniquely determined.

On heavy construction jobs, the helicopter is finding use as a speedy taxi for home office men

who must make a tour of widely separated field operations in the shortest time possible. It keeps isolated crews, whether on dam construction sites or offshore oil well towers, supplied with food, equipment, and replacements of men and machines. The helicopter is finding use as a highly mobile crane on many construction sites. It lends itself to the transporting of buckets of concrete from truck or batching plant directly to forms which might otherwise be inaccessible. In these cases, the conventional concrete bucket is equipped with a flexible exit shaft and rip cord to enable it to be positioned and dumped quickly. As a hoisting device the helicopter was recently used to lift heavy heating and ventilating equipment to the roof of an Atlas missile plant in San Diego, California. A Sikorsky S-58 was used to place 103 tons of such equipment on the plant roof in six hours of flying time. Use of a conventional crane would have required roof reinforcement, higher costs, more time, and wouldn't have resulted in the equipment being positioned within one inch of its final location as the helicopter was able to do.

The future uses of the helicopter in construction are probably limited only by the ingenuity of the men who use them. Specially designed craft should be able to carry heavier loads of equipment designed with "installation by helicopter" in mind. These flying cranes might possess auxiliary equipment, such as power augers for digging the holes for transmission lines. Perhaps they could be equipped with ground clearing devices, making a helicopter a flying bulldozer as well. The helicopter, once primarily a military aid and an instrument of mercy in times of disaster, is now taking its place as a vital piece of equipment in the construction industry.

Sikorsky Aircraft

An 80 foot 2700 pound aluminum tower is being airlifted to its final location. The helicopter was also used to transport crews and string lines on the project.

AUTOMATION

ITS EFFECT ON THE WORKER AND HIS JOB

Part I of 2 Parts

by Reginald F. Woods III, ME '62, BPA '63

A company or industry may turn to automation for a multitude of reasons, of which labor is only one. However, whatever the basic motive, a substantial saving in operative labor is an inevitable result. Fear is often expressed that, since automatic processes increase output per man-hour, subsequent demand for goods and services will be met without full use of the work force. This apprehension is understandable but historically unrealistic. Similar increases have taken place regularly since the Industrial Revolution and the general level of employment has been maintained in spite of increased mechanization, by means of increased product demand and consumption coupled with a reduction of the work week.

Nevertheless, we still find that the vast majority of employees are suspicious of automation and tend to reject it for many reasons. It is quite natural that resentment will be created where machinery displaces workers without other job opportunities being available elsewhere in the company. The older workers are especially fearful of such a result, and although the younger ones most certainly resent it, they are more confident of locating other employment.

In many cases automation will require methods revisions which substitute a lower paid skill for the present one, or it may even force a worker out of the position requiring his skill and leave him in the unenviable position of accepting a lesser job or resigning. When workers see such handwriting on the wall they fight it with all they have, as individuals as well as organized labor groups.

There are strong indications that resistance to change is the most powerful and prevalent labor attitude. This, of course, is a basic human trait and must be intelligently treated in any automation situation. In back of this general resistance lies a complex aggregate of the individual's fear of proving inadequate in the new situation, desire to preserve social status, pay, working privileges of the old system, and fear of the unknown.

As far as individual companies are concerned, automation has very rarely caused wholesale dismissal of labor, although at the same time it is able to reduce operative labor by a large factor. Most managements respect the importance of ensuring that their workers do not regard automation as a job threat, and so they make considerable effort to retain any workers that may be displaced. Fortunately, those firms that are most likely to introduce automation are readily able to absorb these workers for two major reasons. In the first place they will probably be large companies which can transfer workers to other departments. Secondly, at present automation is finding more common application in those industries with greatly expanding output, such as electronics, automotive, and the like. Also, during labor shortages, automation may provide the only means of expanding production to meet increased demand. However, even in industries which are expanding less rapidly, profit and progress often go hand-in-hand, and companies

that employ automation may often make substantial gains in their share of the available market.

Automation vs Skill

The introduction of automation into a plant implies more machinery and the complex control functions which are necessary for its regulation. Therefore it appears quite evident that the employees who direct, man, and service this equipment will require more training, greater skills, and very likely more education. For these reasons, we may expect the automated factory payroll to include a greater percentage of skilled workers and fewer unskilled ones. Therefore, next to a reduction of employment opportunities, the major objection expressed about automation is its apparent effect in redistribution of the work force through "upgrading".

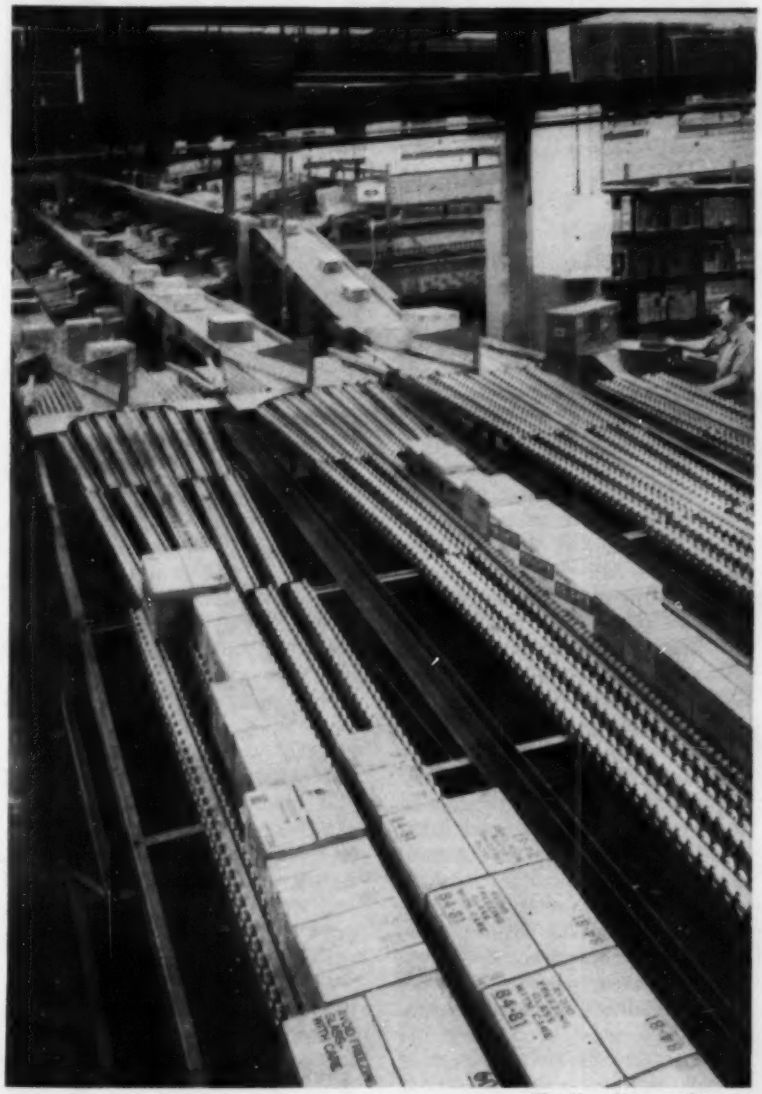
Two strong and diametrically opposed views have arisen on this particular aspect of automation. The management point of view is that "upgrading" is automation's major blessing to labor, because it will abolish the drudgery of monotonous, repetitive work. Superior levels of education and training will be asked of the worker in the automated plant, and such qualifications will command greater compensation and prestige for the individual worker. For these reasons management believes that labor should welcome the advent of automation, because it will "upgrade" the worker into higher, more dignified, satisfying, and rewarding socio-economic positions.

The opposing view of labor maintains that these very same skill and educational requirements will make the average worker virtually unemployable. Not only will he be displaced by the higher productivity of the automatic machine, but he will be unable to work in the automated plant because he lacks the necessary skill, training, and education. In essence labor feels that automation will bring a technological lockout of the common man.

There can be no denial that many skill increases will be required by automation. However, in the opinion of many, the seriousness of the problem has been somewhat overestimated. A recent study by James R. Bright and the Graduate School of Business Administration at Harvard University indicates that it is not true that automation must inevitably mean lack of opportunity for the unskilled worker, or that there will be a tremendous retraining problem. On the contrary, automated processes often actually reduce, or at least do not require more operator skill, after certain levels of automation have been attained. In processes where highly automated machinery provides the skill, effort and control, the average unskilled worker can easily master a new and different job. In addition, many jobs which formerly required long years of experience and training will be reduced to simple machine tending jobs.

Although there will probably not be any widespread unemployment due to changes in skill requirements brought by automation, it is nevertheless likely that new skills will gradually emerge out of the old.

Generally speaking, automated processes require two kinds of operators. First is the "machine-



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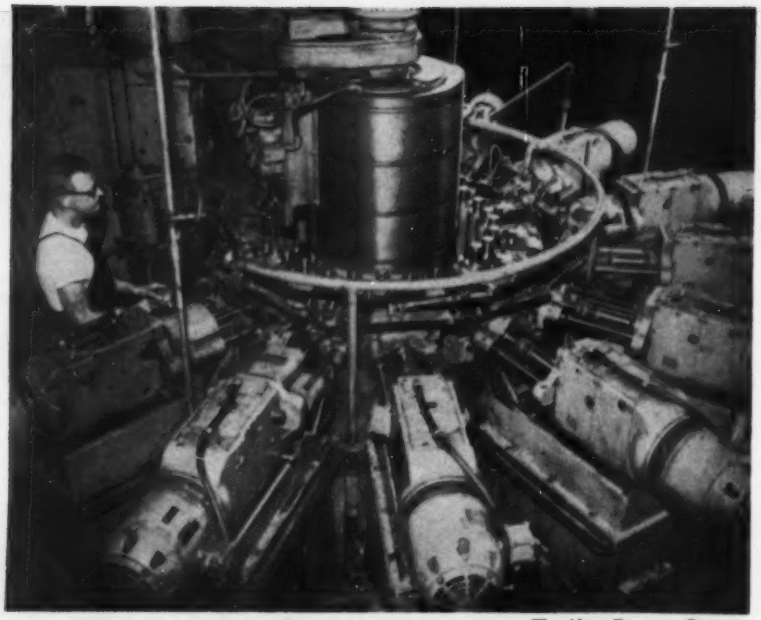
Automation of Colgate-Palmolive warehouse with conveyer belts saves a great deal of manpower and time.



The Alvey-Ferguson Company

True automation: One overseer lets Kingsbury drilling machine do the work, rapidly and accurately.

minder" of the manufacturing industry, and second is the "process monitor" who has long existed in the process industries of chemicals and petroleum.

The machine-minder is a direct descendant of the semi-skilled and skilled worker of the familar mass-production operation. However, the nature and scope of his work has undergone considerable revision with the advent of the automatic machine-tool.

Process-monitoring can be subdivided into three classifications which are a function of the degree of automation of the process. In the first class the operator actually regulates the process by remote control. In the second class, the operator utilizes indicators and displays to regulate production and exerts much less direct influence on the process. In the third class he simply monitors a group of instruments so that he will be informed when and if the process begins to get out of hand. Only in this third class, where a high degree of feedback allows the mechanism to control itself, does the operator actually become part of a fully automatically controlled process. In the first two classes it can be seen that process efficiency and success may depend heavily upon the reaction speed of the operator.

Clearly, however, no simple definition can possibly cover all operative tasks connected with automatic processes. Jobs vary widely according to product, industry, and the degree of automation. As was pointed out earlier, operator skill will be raised in some cases and lowered in others. For example, in the process industries there is a reduction in the need for subjective judgment by experienced skilled workers, while the machine operator of the manufacturing industries remains in a semi-skilled status but has increased responsibility. In spite of the great differences in individual jobs, there is a general trend toward supervision rather than direct regulation of a process, as well as skill based on knowledge and understanding of the equipment and process rather than manual dexterity.

Such significant changes may be conveniently characterized as a general shift from manual elements to "perceptual" and "conceptual" elements in human skill; in other words, the ability to absorb information accurately and efficiently and organize or interpret it for immediate action. These elements are present in varying degree in all skills, so it is not likely that a complete transformation from the motor element will occur, but a distinct change of emphasis between these three elements is bound to be a result of automation.

Changes in the conceptual element are likely to be the most important and significant. Automatic processes are, by nature, fully integrated processes, and no job can be performed in isolation. The worker will be called upon to correlate his indicator and instrument readings with those of others; he will often have to interpret process trends through a series of readings; and he will need to understand the process well enough to take proper corrective action in the event of a breakdown or similar emergency. The worker does not need a high degree of technical competence, but he must have a broad understanding of what is going on around him. Therefore, even though he works according to routine instructions most of the time, the conceptual element of his job will become more and more important.

Along with changes in skill, automation tends to place a much greater responsibility on the individual worker, because it multiplies the damage and loss that his mistakes can bring about. Machinery in the automated factory is far more expensive; a large quantity of material can be wasted if faults are not immediately corrected, and a much greater amount of production may be lost through stoppage because a whole process or even a whole plant may be disabled when one segment becomes inoperative. In this context, responsibility does not imply difficult decision making, but does require that the worker be alert, conscientious, and reliable.

Operators on automatic processes need little or no advanced technical know-how, but they must learn to understand their machines and processes. They may need more or less skill than before, depending upon the job and the process, but a complete break with present skills is quite rare. There is considerable evidence in the recent

literature to indicate that the new operative skills may be acquired through a moderate amount of training on the job.

Automation vs The Physical Aspects Of Work

One of the primary objectives of the automated plant is to create an environment in which the use of heavy labor is at a minimum. This aspect of automation is part of the long evolutionary trend toward the substitution of mechanical effort for muscular effort. The gain to management is increased productivity, while the gain to labor is a much easier job.

Automation will take the physical effort out of heavy work so that jobs will be considerably more attractive to labor, and so that anyone, regardless of physical prowess, can handle the job. In many cases, automated processes have been installed primarily so that women could be employed to do the work. The reduction of unavoidable accumulated fatigue maintains a more consistent work flow, minimizing accidents, waste and scrap, and delays. The worker himself eventually realizes that automation actually provides him with a form of job security against the inevitable day when his muscles and skill no longer are able to cope with the old job.

Much more pleasant working conditions result from use of automatic equipment which moves its own material through the system. A cleaner job environment is possible because dirt and debris do not accumulate and spread around the production area. Moreover, the operator is not required to handle unpleasant waste materials such as oily chips, scrap metal, and similar clothing-staining substances. Remote control makes it possible to locate the workplace at a considerable distance from some of the operations. The effect of automation on job conditions is to improve the working environment as well as to reduce the physical effort involved. Studies show conclusively that employees are highly conscious of the improved working conditions brought about by automation. Frequently they respond to the new environment by taking increased pride in maintaining their equipment in the best possible condition. Such increased morale brings a real dollar benefit to the firm which introduces automation.

Work on the production line of a conventional factory tends to be repetitive and quite monotonous, and therefore devoid of interest to the employee. The pace of the work is often set by the machine rather than the operator. Recent research has yielded interesting evidence on the problem of pacesetting by machines. One study, conducted on an automobile assembly line, leads to the conclusion that "the mass-production characteristic disliked most by a majority of workers in our sample was mechanized pacing."[1] Other research on the organization of repetitive tasks suggests that constraint on the worker, of which pace setting is one aspect, has an important effect on the satisfaction given by the work. Laboratory experiments at Cambridge University also suggest that workers find "time-stress" and "speed-stress" the most difficult working conditions to bear. Although this evidence is not to be construed as conclusive, it does indicate that mechanical pace setting is a problem to be reckoned with.

The worker associated with a fully automated process rarely is called upon to adjust his speed to that of the machine. Usually his work consists of routine checks and inspection according to a preset plan, and only occasionally is he called upon to act – when the machinery malfunctions. However, in the only partially automated process the pace setting problem remains. In such cases the worker is closely tied to the process and may suffer from boredom and fatigue, particularly when the process, although simple, requires constant attention. The more a process becomes automated without being fully automatic, the greater the likelihood of dissatisfaction as a direct result of pace setting by the machine. This trend seems to reverse itself when the process is fully automatic, because the worker is no longer directly involved in the production process.

Many workers operating long sections of fully automatic production lines have expressed satisfaction in the variety of work. They enjoyed working with different kinds of machinery and particularly welcomed the change of pace rather than being tied to one machine day after day. They appreciated their freedom of movement and the fact that they had some choice about how and where to direct their attentions.

In the opinion of many, operators who man complex and extensive automatic production lines most always welcome the sense of responsibility, and they actually seem to enjoy mastering and operating the intricate machinery. The workers also like to feel that a lot depends on them (whether or not it actually does).

Studies by various agencies indicate that workers on every level seem to enjoy a feeling of pride in an outstanding plant. Apparently there is considerable satisfaction, job prestige, and even social prestige, in working in the "finest", most "fully automatic", or "most advanced" plant in the industry or the area. Management often expressed the strong opinion that labor welcomed automatic machinery for combinations of these reasons, provided of course that their job security and pay were not threatened.

A major advantage of automation is the realization of a much less hazardous working environment. Safety seems to improve because there are fewer people in hazardous locations due to the extensive use of remote control devices. Hence, the opportunities for accident per unit of output would drop even if there were no actual hazard reduction. Of course most of the jobs that have some element of personal danger when performed manually have been made automatic. A fundamental effect of automation is to have the materials and parts under mechanical control at all times, and so they are not free to slide, roll, and fall. Automatic removal of waste and other dangerous material also creates a safer environment.

Editor's Note:

Part II, discussing the attitudes of labor and management, will appear next month.

HISTORY OF COLOR PERCEPTION THEORY

by Delia A. Corkey, EP '64

Ever since the dawn of recorded history man has speculated about color and the manner in which he perceives it. Before man had writing, he had some knowledge of mixing pigments for his paintings. As early as 1519, Leonardo DaVinci had set down rules for color mixing. But mixing of colors in pigments differs from mixing of colors in images. Although much was known about mixing pigments, it remained for Newton to show the difference between pigmentation (subtractive combinations) and "pure" spectral colors (additive combinations).

Philosophers have long speculated as to the nature of color perception. The question of whether or not red to one man is red to another has been debated for ages with no conclusion. Others have wondered whether or not color is an integral part of light. Rene Descartes, the French philosopher-mathematician believed that color was independent of light. Sir Isaac Newton showed that white light can be broken down into component colors by passing it through a prism. After the Newtonian revolution, the problem of color perception passed from the philosophers to the physiologists, by-passing the physicists, who were more concerned with the nature of light than with the problem of color perception.

During the nineteenth century, three major theories were advanced to explain the phenomena associated with color perception. The earliest, put forth by Thomas Young and later modified by Hermann von Helmholtz, was based on color mixing by nerve fibers in the retina. About the time that Helmholtz was modifying Young's work, Ewald Hering was developing a theory based on color contrast and after-images. Finally, in the latter part of the century, Mrs. Christine Ladd-Franklin proposed the third major theory, based on an evolutionary development of the eye.

Young's trichromatic theory was not the first. Almost a hundred years before, Lomonosov had proposed the first primary light theory when he said that light is composed of three parts. This theory was not, however, widely accepted. Young, by "starting from the well-known fact that there are three primary colors, sought for the explanation of this fact, not in the nature of light, but in the constitution of man"[1].

Thomas Young did not realize how right he was when he wrote: "The theory of light and colours, though it did not occupy a large portion of my time, I conceived to be of more importance than all that I have ever done, or ever shall do besides."[2] His approach to the subject set the pattern for future investigators to follow for many years. He first presented his theory in the Bakerian Lecture to the Royal Society. Young started out by saying that the variety of spectral colors contains over 150 distinguishable hues. He expressed the belief that it was impossible for each point on the retina to have a separate nerve fiber capable of vibrating in perfect unison with each hue received. He felt that it was necessary to limit the number of these sensitive nerve types to three; those for perceiving reds, yellows, and blues. He later changed these colors to green, violet, and red. His theory is quite simple. We experience three different color sensations. Light of different kinds excites these sensations in different proportions, and combinations of the three primary sensations produce the variety of visible colors. Young tried to find the simplest arrangement that would enable the eye to receive and discriminate color. He did not attach much importance to the three colors as they were of an intuitive nature. It is not known what experiments he did to confirm this hypothesis, as he left no quantitative data.

Young's work attracted no immediate attention. It remained for Helmholtz, fifty years later, to rediscover and adopt it with some modifications. In his *Popular Lectures on Scientific Subjects*, Helmholtz states, "According to this theory, the perception of each of the three fundamental colours arises from the excitation of only one kind of sensitive fibers, while the two others are at rest; or at any rate are but feebly excited. A brilliant, pure colour produces a powerful stimulus, and yet, at the same time, a great degree of sensitiveness to the admixture of other colours, in those systems of nerve fibers which are at rest."[3] This theory has come to be known as the Young-Helmholtz theory of color perception.

About the time of Helmholtz's work, Ewald Hering was developing his own theory of color perception. These two brilliant men often found themselves on opposite sides of issues, and on color perception they differed widely. Helmholtz's theories were of an empirical nature; Hering's were of a nativistic outlook. Hering felt that "there is an ideated subjective visual space wherein the sensa-

tions of the separate nerve fibers are supposed to be registered according to certain innate ideas."[4] He was intrigued by the repeated appearance of certain color pairs in an after-image situation. On the basis of his observations, he explained color perception by a three-substance, six-color theory. He said that in the retina were three types of substances; a red-green, a blue-yellow, and a black-white substance. These can be stimulated by either of two opposing reactions, dissimilation (or catabolism), giving the more violent colors: white, yellow, or red; or assimilation (or anabolism) giving the quieter colors: black, blue, or green. In addition to theory, Hering also developed numerous instruments and pieces of apparatus to measure human color vision, helping to give the new science its nickname of "brass-instrument psychology".

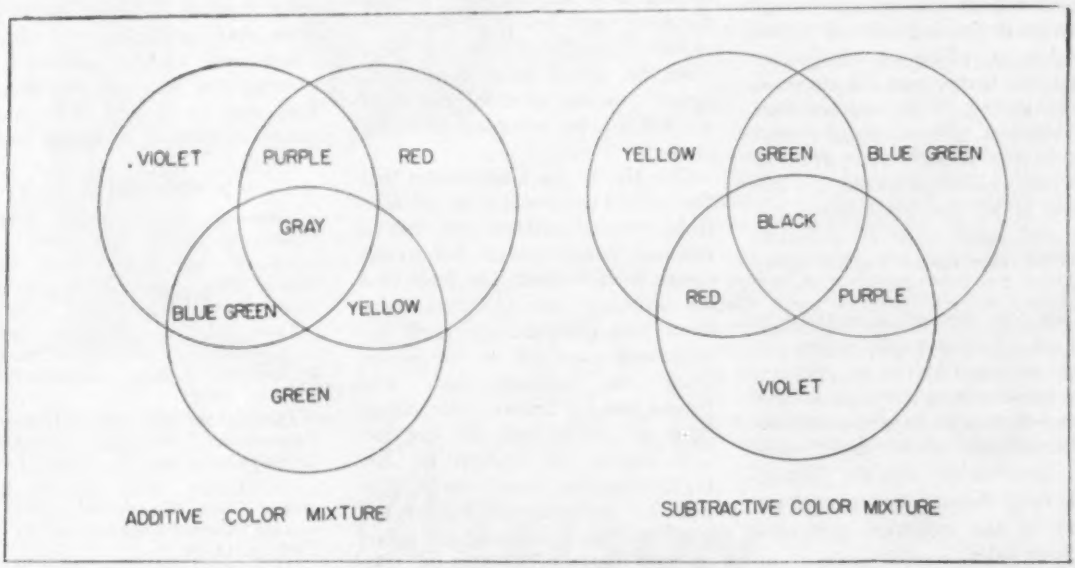
These two theories provided a contrast to each other for a number of years until the close of the nineteenth century, when another theory, not based on either of the two, was proposed. This new theory of color perception, based on color deficiencies, arose from the discovery of color blindness.

Christine Ladd-Franklin proposed this evolutionary theory of color vision in 1892. She said that monochromatism, or black and white vision, is the most primitive form of seeing. This is later evolved into a dichromatic vision by the addition of the ability to see blue and yellow. Finally, the addition of a green and red pair give trichromatism, or full color vision. This is based on studies that show that red-green colorblindness is more common than blue-yellow, and that monochromatism is the rarest and therefore is lower on the evolutionary scale. She proposes four primaries: red, green, blue, and yellow, each perceived by a corresponding retinal cone. This part of her theory was motivated by an incongruity in the Young-Helmholtz theory; namely, that a red-green colorblind person could distinguish yellow, a color that was supposed to be a product of red and green. Colorblindness could be accounted for by four types of retinal cones.

Since these theories were presented, arguments for and against them have also been presented. Even today we cannot pick any one of the three and say with any degree of certainty that it is right. Later experimenters have shown that the retina of the eye contains two types of sensory receptors, "rods" and "cones". The fovea, or small area upon which light from the center of the visual field is focused, contains cones only, and these cones decrease in density with distance from the fovea, although no area of the retina is entirely without them. The cones are active in daylight vision, permitting both achromatic and chromatic vision, whereas only the rods are active in reduced illumination, permitting only achromatic vision. The way in which these rods and cones function is not known, and research is still underway to determine their precise functions. Some attempts to find the functions have led to the conclusion that there are three specific types of paths for the electrical impulses generated when the retina is stimulated. Hartridge, by stimulating very small areas of the retina with white light, found that the resulting stimulus was either red, green, or blue. These tests were held to prove the existence of three types of receptors in the human fovea.

There has been little experimentation to prove or disprove either Hering's or Ladd-Franklin's theory.

This, then, was the state of color perception principles until quite recently, when Dr. Edwin H. Land of Polaroid, Inc. doing research in another field, accidentally made an important discovery in color perception. In order to get the complete story, we must go back to the year 1885 when the physicist James Clerk Maxwell



Tom Dedio

These diagrams show how colors are mixed in the two mediums, pigment and light. The additive diagram shows the results of pigment mixture. The subtractive diagram shows the results of mixing colored light.

was doing his classic experiments in color photography. He discovered that "full-color pictures can be reproduced by making three black and white photographs of the same scene respectively through red, green, and blue filters. If these photographs are projected through the filters through which they were made, and are superimposed upon each other on a screen, a true full-color reproduction of the original scene will be observed."[5]

Dr. Edwin H. Land of Polaroid, Inc. repeated Maxwell's experiments in order to learn more about color in images for making color film. One day, he turned off the blue projector but, contrary to the predictions of classical three-color perception theory, the image on the screen retained much of its natural color.

The major feature of his system is that the picture taken with light of longer wavelength must also be projected with light of longer wavelength. This system does not work in reproducing the solar spectrum, as the filters do not pass enough information. It also cannot reproduce "artificial randomness," showing that we need the "random variation that occurs in natural scenes if we are to see more than the colors predicted by classical color theory."[6] It has also been shown by Land that neither the total intensity of the two projection beams nor systematic alteration of the intensity of either one has an effect on the colors seen. His theory can be summed up by saying, "Thus we see that the random point-to-point variation in the relative intensities of the two colors projected on the screen is all the information the eye and mind need in order to perceive the entire visible spectrum."

Land has devised a simple system of obtaining all colors by using any two colors as primary. The question now remains: Is this a new theory or merely a modification of one of the older ones, i.e., the highly flexible Young-Helmholtz theory? Let us examine some of the evidence presented by both sides.

Critics of Land's work have said that his pictures are 1.) either "memory" color, or 2.) subjectively possible, because a projection beam of red and white through red and green filters contains all colors, and therefore nothing new has been discovered. Last May, at Cornell, Land showed some of his work, including a slide flashed on the screen for one-twenty-thousandth of a second. All those present recognized it as an American flag with green stripes, in spite of the "memory" of the flag as having red stripes. The subjectiveness of the colors seen is also not in question as color photographs of the projections show the true colors of the original scene. Land has shown full color pictures that have been taken and then projected through two filters in the yellow portion of the spectrum. This would show that color is possible, although insufficient visual information is present, according to classical theory. To test the "objectiveness" of the colors seen, even though a blue apple appears blue in the projections, a spectroscope was turned on the screen. It showed that the only colors on the screen were a mixture of red and white.

Most other criticisms of Land's work have been answered successfully. When an experimenter finds a series of data that conflicts with a previously accepted hypothesis, it is not enough for him to merely throw the old out; he must substitute a new explanation. Several theories have been advanced to explain Land's findings. These must be tested more thoroughly before any one or combination of several can be accepted as being correct.

One theory, by Land, states that the human eye evolved to aid man in his natural environment; that is, not just to see sunsets, but to see tigers in the grass. He feels that by working with isolated color spots and surroundings, early experimenters got off on the wrong track. He believes that "The proper test for human color vision, then, is a scene that, like the natural scenes we evolved in, has highly complex forms, and highly complex and diversified color—the kind of scenes our eyes are called on to resolve in daily living."[7] The physicist-author, John W. Campbell, feels that the eye does not record color, but encodes it. The fact that we see full color using two shades of yellow for projections makes it clear that we are not dealing with a simple measuring-and-reporting system, but rather with a complex encoding and decoding system that operates in terms of a longer and shorter wavelength of light. These two views would lend some weight to the almost ignored Ladd-Franklin hypothesis.

A committee of Cornell undergraduates formed to work with the problem now have the belief that the eye needs two separate signals of the same scene in order to perceive color. One signal shows variation in densities, giving black and white. Two signals will measure two dimensions, contrast and color. Yet, these signals must be distinctly different. We could not get color when we used two long records or two short records, projecting them in the standard fashion.

These experiments have raised questions as to the nature of light, such as why each end of the spectrum fades out into purple and whether the human system is a linear system of perception. All these and many more questions remain which only research will answer. "Whatever the ultimate results of his work may be, Dr. Land has succeeded in shaking up the long-settled convictions of color theorists."[8] The classical theories may prove to be right, in which case Land's work will be incorporated into one of them, or they may be shown to be inadequate. At this point no one knows.

FOOTNOTES

[1] Maxwell, James Clerk, *Scientific Papers*, (Cambridge Press, 1890)

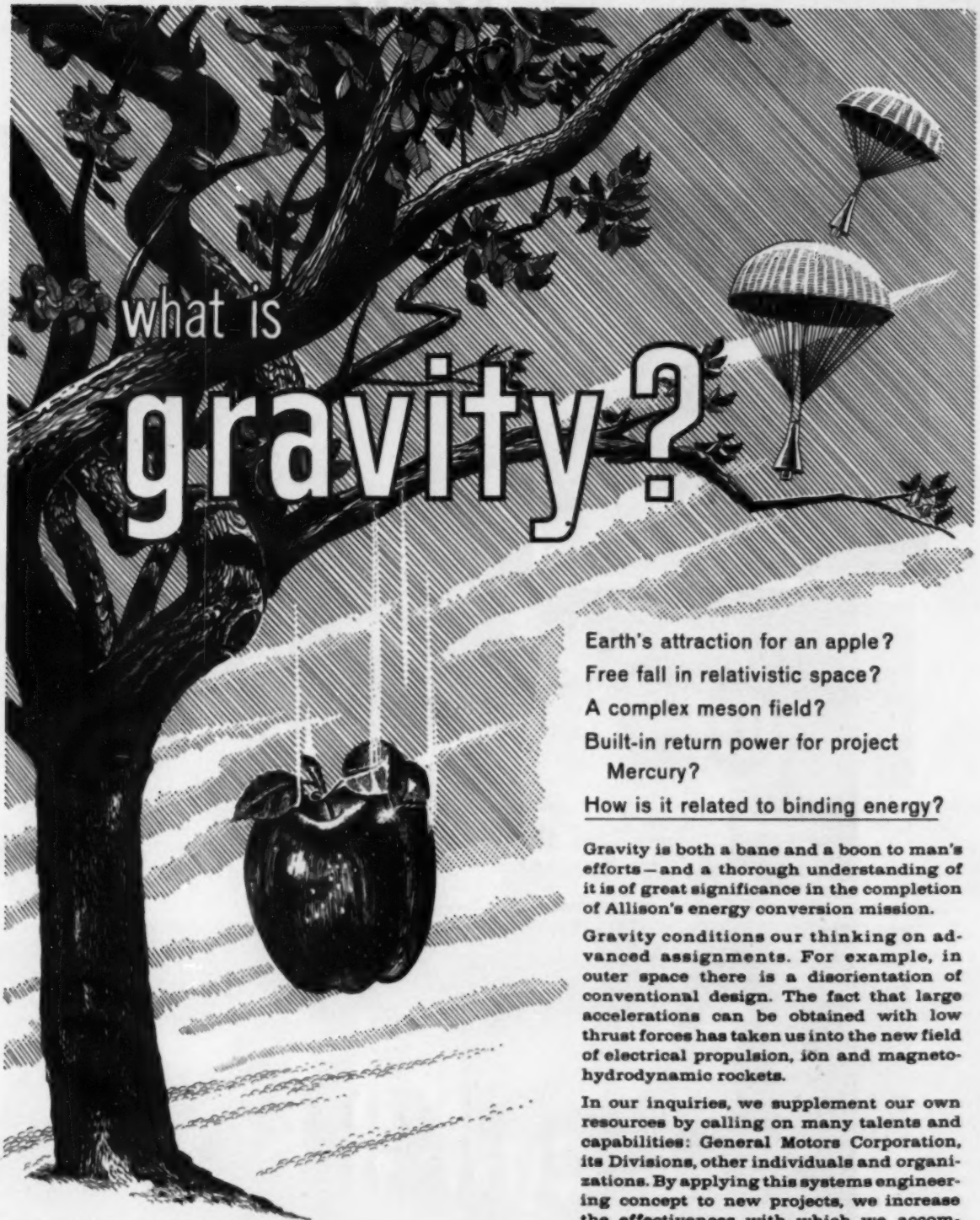
[2] Wood, Alexander, *Thomas Young, Natural Philosopher*. (Cambridge University Press, 1954)

[3] von Helmholtz, Hermann, *Popular Lectures on Scientific Subjects*, trans. by E. Atkinson, (London, Longman, Green, and Co., 1884)

[4] Boring, Edwin G., *A History of Experimental Psychology*, (Appleton-Century-Crofts, Inc., New York, 1957)

[5, 6, 8] Corkey, Delia A., and B. J. Simon, "New Theories of Color Perception," *Cornell Engineer*, vol. 25, May 1960, p. 14–18.

[7] Campbell, John W., "Color Vision . . . The Land Experiments," Analog, vol. LXIV, February 1960, p. 83–103.



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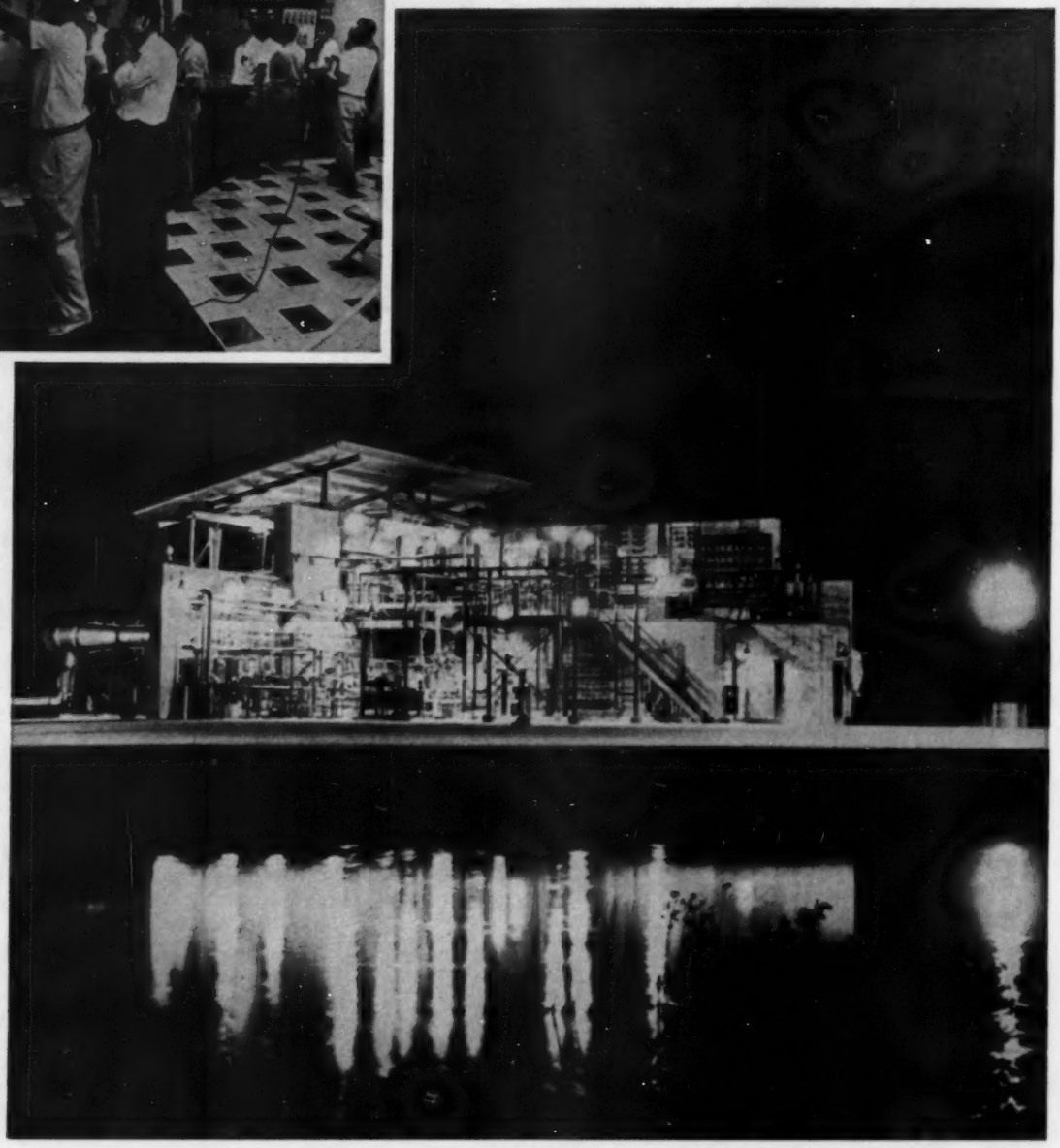

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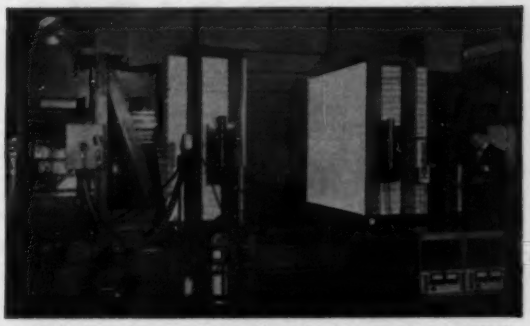

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by Howard Clapsaddle, ChemE '65

In this age of ballistic missiles, our radar warning system must be extremely powerful and sensitive. A few years ago, radar had only to look for airplanes, comparatively large and slow-moving targets. Today and in the future, our defense radar must be able to spot the small and fast-moving targets provided by missiles. This calls for the constant development of more powerful and efficient radar.

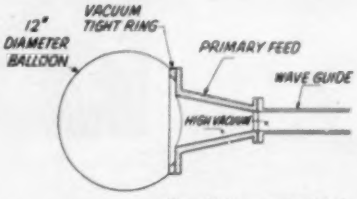
For several years, the Cornell Aeronautical Laboratory at Buffalo, New York, has been conducting radar research for the Advanced Research Projects Agency of the Defense Department, under the direction of the Army Rocket and Guided Missile Agency. Researchers in this project, the High Power Project, believe that the answer to the need for more powerful radar lies in high power microwave radar waves of less than thirty centimeters wave length. Working with wave lengths of about ten centimeters, the Cornell Aeronautical Laboratory has found that radar of much greater peak power than that being used today can be built.

The first major accomplishment of the Laboratory was made about two years ago: their radar transmitter emitted a twenty-one megawatt peak power beam during each pulse. This shows what progress the High Power Project had made, for, even today, a 2.5 megawatt transmitter is considered powerful.

At a new location ten miles northeast of the Laboratory, Cornell radar research men are now experimenting with a transmitter capable of fifty megawatts of peak power. The transmitter's parabolic antenna, sixty feet in diameter, is mounted on a fifty-foot tower. The tower is, in turn, bolted to a concrete foundation twenty by twenty by six feet, which rests on bedrock. The whole antenna assembly is perforated to cut down wind resistance and prevent the accumulation of snow and rain. It can be pointed in essentially any horizontal or vertical direction, and its speed of tracking adjustable at a rate of ten degrees per second with a precision of one minute in the final adjustment.

To emit very high power microwaves, the Cornell Aeronautical Laboratory's radar equipment incorporates improvements over conventional radar. Its waveguide (which transmits microwaves to the feed unit, where they are emitted) is pressurized with a gas dielectric. This type of waveguide is more efficient than the conventional evacuated waveguide, which has a power loss due to ionization of air. The feed unit is an improved type, capable of emitting pulses of more than fifty megawatts. The duplexer, a device allowing the antenna to be used as both transmitter and receiver, is especially designed to handle the unconventionally high power of the radar.

VIEW OF ANTENNA PRIMARY FEED



Cornell Aeronautical Lab.

Feed Unit for 21-Megawatt Transmitter. It operates with the inner section either evacuated or pressurized with dielectric gas; the outer section between the Mylar window and the plastic balloon is filled with a dialectric gas slightly above atmospheric pressure. At the point where energy emerges through the Mylar window, the dimensions of the horn feed unit are such that ionization and resulting breakdown would occur at eight megawatts.

The High Power Project has several important goals. One of these is to determine the optimum power level of high power radar which will bring about the most desirable ratio of signal to noise. Noise is caused by unwanted waves, such as thermal waves emitted by the earth, being received at the antenna. Dielectric materials – materials which do not interfere with or conduct electromagnetic waves – must be found that can withstand very high potentials. Another pressing problem is to determine the peak and average power limits of transmission lines and duplexers.

The Cornell Aeronautical Laboratory has shown that new materials and types of equipment can endure power loads which were previously thought to be much too high for practical use, and that high power microwave radar is a possibility for defense radar. The past success of the High Power Project is a good indication that the present goals of the Laboratory will be reached, and that multimegawatt microwave radar will become operational as part of our defense system.

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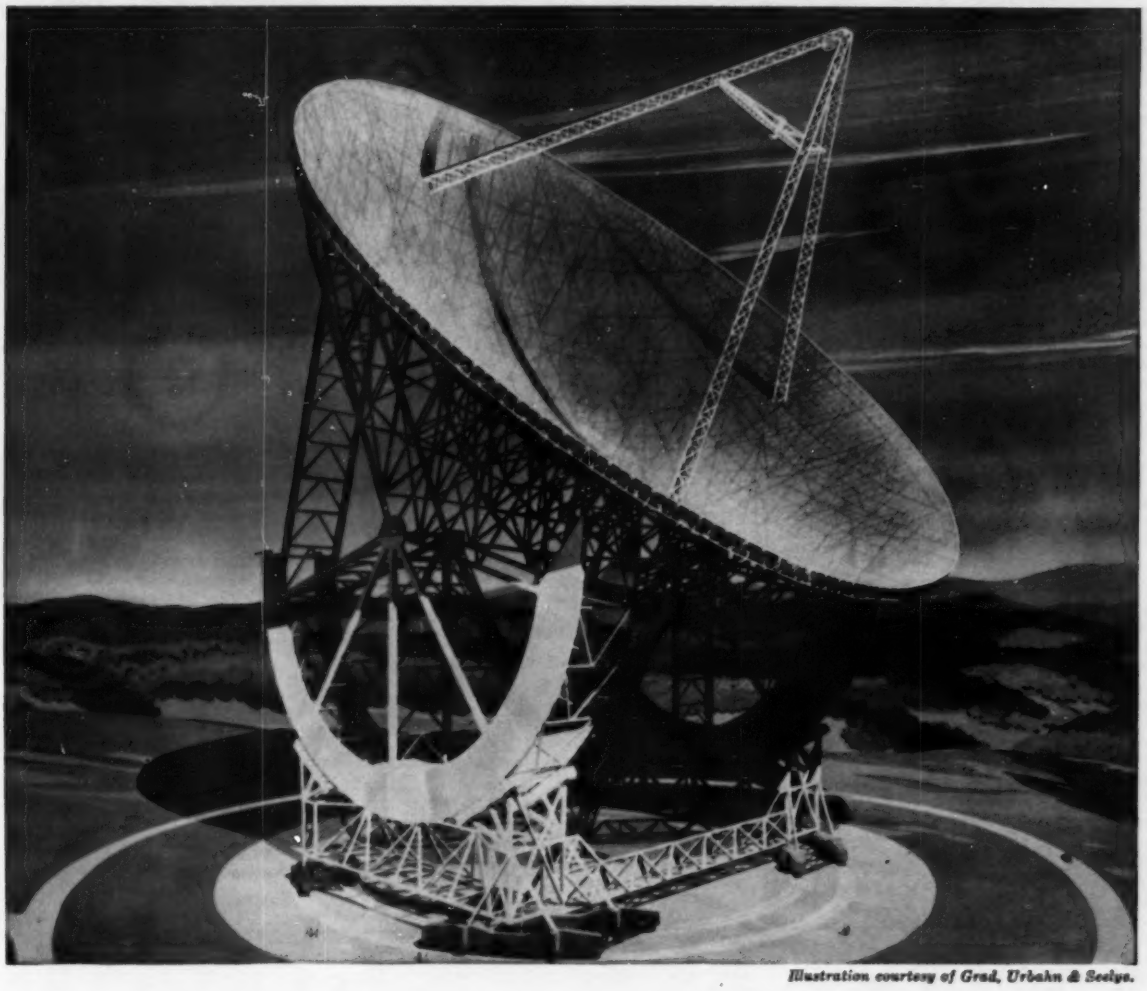

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationships between the College and its alumni."

THE PRESIDENT'S LETTER—

In the November letter I mentioned that the Executive Committee had approved submitting a new Constitution and By-Laws to the membership at the Annual Meeting in May 1961. In the following pages the proposed Constitution and By-Laws are shown. The changes included in these proposals deal primarily with the wording of the purposes of the Society and have been designed to comply with current Internal Revenue Service rulings to insure that we will not be subject to taxes. Changes also bring up to date formation and duties of the current committees. I hope you will all read these carefully and let me have any comments you may care to make. A great deal of credit goes to Rox Fuller and his committee for the large amount of research work that went into this project and I hope that it meets with the general approval of our membership.

Red Zeman of Cleveland reports that they had a bang-up luncheon meeting on February 4 at the Union Club. This meeting was sponsored by the Cornell University Council and put on by the joint efforts of the Society of Engineers and the Cleveland Alumni Club. 265 people were in attendance which included 24 prospective students and their parents. Among the speakers was Professor Robert L. Sproull, Class of '40, Director of the New Materials Science Center.

Our next meeting in New York will be the Annual Meeting on May 4 at the Engineers' Club, 32 West 40 Street. We will have as our guests at this meeting the prospective freshmen who have been accepted in the Engineering College. I hope we will see a lot of you there.

PAUL O. GUNSALUS

PROPOSED CONSTITUTION

Article I—Name and Purpose

Section 1—The name of this Society shall be the Cornell Society of Engineers.

Section 2—The purpose of the organization shall be solely charitable for the advancement of engineering education or science, to wit: to promote the welfare of the College of Engineering of Cornell University and to foster a closer relationship than would otherwise be the case between the College and its alumni, for the benefit of that institution.

Article II—Funds

Section 1—All funds accruing to this Society from whatever source shall be used for the purposes above mentioned and no others, except for ordinary running expenses. In the event of the dissolution of this Society, all funds remaining to its credit after payment of its just debts shall become the property of Cornell University, to be used for the benefit of the Engineering College.

Section 2—No part of the funds of this society shall inure to the benefit of any member, except as he be indirectly a beneficiary of its normal charitable and educational endeavors.

Article III—Fiscal Year

Section 1—The fiscal year of this society and of each Regional Section thereof shall run from July 1 in each year to the following June 30.

Article IV—Executive Committee

Section 1—The entire charge and control of this society and its affairs, funds and property shall be vested in an executive committee, subject only to the provisions of this constitution and the by-laws of the society.

Section 2—The Executive Committee shall consist of the President, who shall be ex-officio chairman, the other duly elected officers, the three most recent living past presidents, two alumni representatives of each Engineering School, the chairmen of standing committees and the honorary officers

Section 3—The Executive Committee shall meet at least twice a year, one of which meetings shall be within a week prior to the Annual Meeting of the Society. Other meetings of the Executive Committee may be called at the discretion of the President, and shall be called at the request of any three members of that committee.

Section 4—Seven members of the Executive Committee shall constitute a quorum, except that no more than three of the members counted toward a quorum may be honorary officers.

Section 5—The Executive Committee shall have the power to remove from office any officer or committee member, or to expel any member of the society for good cause, upon due notice and after a hearing, by vote of three-fourths of the committee members present.

Section 6—A vacancy in any office of the society, other than that of President, shall be filled by the Executive Committee at its next meeting, for the balance of the unexpired term.

Article V—Membership and Dues

Section 1—The following persons shall be eligible for membership:

(a) Those who have at some time been registered in the College of Engineering of Cornell University as candidates for an undergraduate or graduate degree.

(b) Those who are or have been members of the Engineering Faculty at Cornell University.

(c) Those alumni of other colleges or departments of Cornell University who are actively engaged in the practice of engineering; subject, however, to approval by the Executive Committee of the Society in each case coming under this classification.

Section 2—Membership shall be on a yearly basis, running from July 1 to June 30.

Section 3—Any eligible person shall become a member upon payment of dues for the current year.

Section 4—Dues shall be at the rate prescribed in the By-laws. The acceptance by the society of advance payment of dues shall continue membership in force for the period covered by the advance payment, even though the dues may have been increased subsequent to the receipt thereof.

Section 5—No part of dues nor any advance payment thereof shall be subject to refund for any reason.

Section 6—The society shall make available to its members a membership certificate, of such form and under such conditions as prescribed in the By-laws.

Section 7—Honorary membership may be granted by the Executive Committee for outstanding service to Cornell University or to the Engineering profession; such membership to be on a yearly basis, unless otherwise determined by the Executive Committee in each case.

The Dean of the College of Engineering, the Assistant Deans and the Director of each School or Department recommending the granting of engineering degrees shall be ex-officio honorary members, each for the term of his respective office.

Honorary members shall be exempt from the payment of dues, and shall be entitled to all the rights and privileges of membership, including the rights of voting and of holding office.

Article VI—Officers

Section 1—The officers of this society shall be a President, an Executive Vice President, a Secretary and Treasurer who may be the same or separate persons, a Recording Secretary, and a Membership Secretary.

Section 2—These officers shall be elected and installed at the Annual Meeting of the Society, to hold office for one year from the ensuing July 1, or until their successors are duly elected and take office.

Section 3—Each duly constituted Regional Section of the Society shall at its annual meeting elect a President to serve for one year, from the ensuing July 1, who shall by virtue of that election become a Regional Vice President of the Society and a member of its Executive Committee.

Section 4—Regional Sections may elect such other regional officers as may be necessary or convenient for the transaction of the business of their sections.

Article VII—Duties

Section 1—The President shall be the executive head of this Society, and shall preside at meetings of the Society and of the Executive Committee. He shall be ex-officio Chairman of that committee and a member of all other committees, except the Nominating Committee. He shall appoint such standing or temporary committees and make such other appointments as provided in the By-laws or as directed by the Executive Committee, with the advice and consent of that committee. It shall be his duty to see that the Constitution and By-laws are upheld, to supervise the work of the various committees, to call meetings of the Society and its Executive Committee, and otherwise to promote the interests of the Society. He shall make and cause to be published an annual report of the Society.

Section 2—The Executive Vice President shall, in the President's absence, incapacity, resignation or removal, act in his stead. When so acting, he shall assume all the rights and duties of that office. He shall assist the President in all the affairs of the Society, and shall perform such other duties as the Executive Committee may direct.

Section 3—The Secretary shall carry on the correspondence of the Society and shall during his term of office maintain a file of its correspondence and other records, which he shall deposit in the archives of the Society at the conclusion of his term. He shall, under the direction of the President, give notice of meetings of the society and of the Executive Committee, and shall perform such other duties as the Executive Committee may direct.

Section 4—The Treasurer shall maintain the funds of the Society and shall disburse them under the direction of the Executive Committee. He shall keep careful account of receipts and expenditures and shall report upon the financial condition of the Society at each meeting of the Executive Committee. He shall, immediately upon taking office, cause an audit of the financial operations of the previous year, to be made by an independent auditor, which audit shall be presented for approval to the Executive Committee at its fall meeting. He shall be responsible for the preparation and submission to the Executive Committee at its fall meeting of a budget forecasting the year's operations, and shall be responsible for the maintenance of expenditures within that budget.

Section 5—The Recording Secretary shall keep the minutes of meetings of the Executive Committee and of the Society, and shall see that minutes of each such meeting are published to the members of the Executive Committee promptly following the meeting. He shall be responsible for maintaining the archives of the Society, and shall see that copies of all reports, all budgets, and all minutes of meetings are deposited therein.

Section 6—The Membership Secretary shall maintain an accurate record of the membership. He shall maintain a safe repository for the archives of the Society. He shall regularly transmit to the editors of the Cornell Engineer orders indicating

the number of copies of each issue to be printed for the account of the Society and shall see that the mailing records are properly maintained. He shall record orders for membership certificates and issue instructions for their execution. He shall receive and deposit to the account of the Society payment for dues, membership certificates and other funds and shall render an accurate accounting thereof to the Treasurer.

Article VIII—Meetings

Section 1—There shall be at least two meetings of the Society during each fiscal year, one of which shall be the Annual Meeting, and shall be held during the first half of May, in the city of New York.

Section 2—Other meetings may be held at such times and places as may be directed by the Executive Committee.

Article IX—Regional Sections

Section 1—A regional section of the Society shall be set up upon the petition of any twenty members of the Society, or whenever, in the opinion of the Executive Committee, the number of Cornell Engineers and the degree of interest in any locality shall warrant.

Section 2—Each section shall have the power to elect such officers as it sees fit, and to carry on such other activities as are consistent with the purposes of the Society.

Section 3—Each regional section shall, immediately following its annual meeting and election of officers, inform the Secretary of the Society of the names and addresses of those officers.

Section 4—The duly elected President of each regional section shall automatically become a Regional Vice President of the Society, and a member of the Executive Committee

Section 5—The Society shall provide such financial and other assistance to each regional section as specified in the By-laws or as directed by the Executive Committee.

Article X—Amendments

Section 1—Amendments to this Constitution, after approval by the Executive Committee, may be adopted by majority vote of those present and voting at any annual meeting or at any special meeting of the Society called for that purpose, provided notification of the proposed change is made in the announcement of the meeting, and further provided that the membership has been notified of the proposed change at least ten days prior to the meeting.

Section 2—Publication of the proposed change in an issue of the official publication of the Society mailed fifteen days prior to the meeting shall constitute sufficient notice to the membership.

Section 3—Articles I and II of this Constitution shall not be amended.

PROPOSED BY-LAWS

Article I—Headquarters

Section 1—The Society shall maintain a headquarters in the City of New York, where mail addressed to the Society may be received, and where the archives and membership records shall be maintained.

Section 2—The headquarters may for convenience be located in the office of the Cornell Club of New York, or of the Cornell University Placement Service.

Section 3—The headquarters will ordinarily be under the direct supervision of the Membership Secretary.

Article II—Funds

Section 1—The funds of the Society shall be kept in such depository (ies) as from time to time may be designated by the Executive Committee.

Section 2—Withdrawal, payment or transfer of the funds of the Society shall be upon the signature of the Treasurer, or if the Treasurer be unable to act, upon the signature of the President.

Section 3—Withdrawal, payment or transfer shall be made only by explicit authorization of the Executive Committee in each case.

Section 4—In the case of current running expenses, submission and approval of an itemized Treasurer's report at a subsequent meeting of the Executive Committee shall be construed to have been adequate authorization.

Section 5—Funds of the Society may be expended, under the direction of the Executive Committee for:

A. Gifts to the Engineering College, or to Cornell University for the benefit of the Engineering College.

B. Prizes for scholarship or engineering excellence, or the like.

C. Organizational support of Regional Sections of the Society.

D. Promotional activities to secure suitable candidates for admission to the Engineering College at Cornell University.

E. Support of the Cornell University Placement Service.

F. Such other charitable purposes for the advancement of engineering education or science as may from time to time be authorized by the Executive Committee.

Article III—Dues

Section 1—Dues for membership in the Society shall be Five Dollars per year, payable in advance.

Section 2—Dues received during the year shall run only to the end of the Society's fiscal year, except that dues received during May or June shall cover the following fiscal year.

Section 3—Membership shall be free upon application to those who are eligible, during the year following the graduation of their class from Cornell University.

Section 4—Subscription to the Official Publication of the Society shall be included in the dues charged.

Section 5—Dues, separate from those charged by the Society, shall not be charged by the Regional Sections. However, nothing in this section shall preclude the assessment of charges to cover the costs of individual Section meetings.

Section 6—Upon request by any Regional Section, including a list of paid members of that Section, the Executive Committee shall authorize the payment to the Section of One Dollar for each such paid member for running expenses.

Article IV—
Engineering School Representatives

Section 1—Two alumni representatives from each Engineering School shall be appointed by the President with the concurrence of the Executive Committee.

Section 2—The term of office of such school representative shall be two years.

Article V—Committees

Section 1—Committee Chairmen and members shall be appointed by the President, with the advice and consent of the Executive Committee.

Section 2—Standing committees shall be those having continuing charge of various aspects of the operations of the Society, as specifically listed below.

Section 3—Special Committees may from time to time be set up for specific purposes, by authorization of the Executive Committee.

Section 4—Representatives of the Society on the Engineering College Council, and on the University Committee on Alumni Trustee Nominations shall be considered Standing Committee Chairmen.

Section 5—The Chairman of each Standing Committee shall be, or upon appointment and confirmation shall automatically become, a member of the Executive Committee.

Section 6—The terms of office of the representatives on the Engineering College Council and on the University Committee on Alumni Trustee Nominations, except those appointed to fill the unexpired terms of previous incumbents, shall each be three years, to expire on the June 30 next following the expiration of that period from the date of appointment.

Section 7—Where more than one representative of the Society shall be appointed to any such board as listed in Section 6, appointment for shorter terms may initially be made, so that the terms of the representatives will overlap.

Section 8—The terms of all other committee chairmen and members shall expire on the June 30 next following appointment, unless upon the earlier rendering of a final report the committee shall be discharged of its duties.

Section 9—The chairman of each committee shall report to the Executive Committee upon demand, and shall render a final report at the annual meeting of the Executive Committee.

Section 10—Committee members are invited to meet with the Executive Committee, but except for the Chairmen, have no vote therein.

Article VI—Duties

Section 1—In addition to those specified in the Constitution, the following are duties of the persons or committees indicated:

Section 2—President

A. (Immediately upon election) Appointment of committees and representatives.

B. (During the summer) Obtaining lists of regional officers from the regional sections.

C. Making and disseminating a roster of the Executive Committee.

D. Setting up the summer meeting of the Executive Committee.

E. Forwarding sample signatures of himself and the Secretary to the University Printer for reproduction on membership certificates.

F. (Prior to September 5, and prior to the fifth of each succeeding month including May 5) Preparation of the "President's Letter" for publication in the Cornell Engineer. The first letter should be accompanied by copy for a new masthead.

G. (Periodically) Calling of, and notification of members concerning Executive Committee meetings.

H. (At end of year) Preparation of "Annual Letter," obtaining copy for the Dean's report, and arranging for publication.

I. Preparation of letter to new graduates and other material for inclusion in Annual Letter.

J. Maintenance of close liaison between the Administration of the Engineering College and the Society.

Section 3—Secretary

A. (Immediately upon election) Arranging for new letterheads and distributing them among the officials of the Society as needed.

B. (Prior to the Annual Meeting) Obtaining from the Admissions Office a list of the accepted candidates for admission to the Engineering College in the metropolitan area, and in conjunction with the President, determining the list of invitations to the Annual Meeting.

C. (At the Annual Meeting) Introducing an appropriate resolution to cover withdrawal of funds from the banks.

D. (Following the Annual Meeting) Obtaining and preparation of signature cards, and notifying the banks of the new officers authorized to withdraw funds.

Section 4—Treasurer

A. (Immediately upon election) Obtaining the books of the Society from the outgoing Treasurer.

B. (After submission of the audit) Reconciling any discrepancies which may be found.

C. (Monthly) Reconciling the bank statements.

D. Maintaining the books of the Society in such form as directed by the Executive Committee.

Section 5—Membership Secretary

A. Maintaining a list of those who customarily attend meetings.

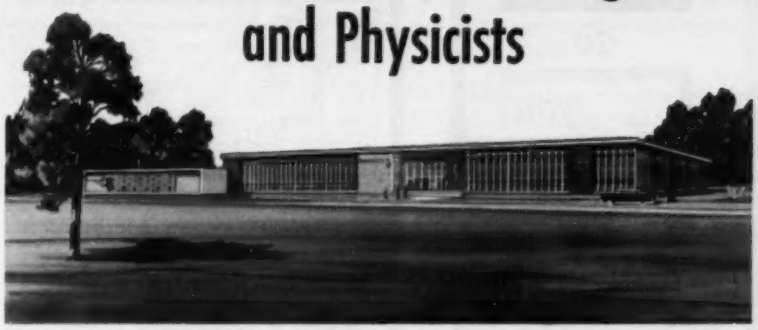
B. Keeping a record of those whose memberships are paid in advance.

C. Arranging for suitable enclosures concerning membership with the Annual Letter.

D. (In May) Obtaining from the Engineering College a list of those expecting to receive degrees in June.

Section 6—Archives Committee: Periodically to collate and edit the archives, to cause two copies of the minutes of Executive Committee Meetings, Treasurer's reports and President's Annual Letter to be bound in book form, by years, and to deposit one copy in the archives of the Society and one copy in the Engineering College library.

Electrical and Mechanical Engineers and Physicists



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Section 7—Awards Committee: Arranging for the presentation and marking of awards for Engineers Day and other awards as authorized by the Executive Committee.

Section 8—Meetings Committee: Arranging for meetings of the Society, obtaining and entertaining speakers, sending out meeting announcements, obtaining names of those present, collecting charges, if any, and transmitting collections to the Membership Secretary for deposit.

Section 9 — Membership Committee: Preparing and mailing two follow-up letters yearly following the Annual Letter, to be mailed in September and November, respectively.

Section 10—Nominating Committee: In addition to recommending to the Executive Committee nominations for officers of the Society, to observe the diligence and interest of committee members and other members of the Society and to recommend to the President and the Executive Committee the appointment of those who appear qualified.

Section 11—Placement Committee: To act in liaison with the Cornell University Placement Service and otherwise to furnish assistance in the employment of Cornell Engineers.

Section 12—Publications Committee: To recommend, and under the instructions of the Executive Committee to implement directives relating to the official publication of the Society, including fees charged and to prepare and publish such other publications as the Executive Committee shall direct.

Section 13—Publicity Committee: To see that notices of meetings and other publicity relating to the Society are printed in the Alumni News, the Cornell Engineer and elsewhere, and through all proper means to see that the Society and the advantages of membership therein are brought to the attention of the public.

Section 14—Regional Sections Committee: To promote the formation and effective operation of regional sections, to maintain close liaison with the officers thereof by periodic visitation and otherwise.

Article VII—Regional Sections

Section 1—It is not contemplated that Regional Sections shall maintain separate treasuries, except for the limited funds required for routine expenses.

Section 2—Upon demand, any Regional Section duly organized or in process of organization may be advanced $100.00 per year by the Treasurer of the Society toward anticipated receipts.

Section 3—To a limited degree, the Society may underwrite excess costs of annual or other special regional meetings. Each such case should be taken up with the Regional Sections Committee and approved by the Executive Committee.

Article VIII—Official Publication

Section 1—The official publication of this Society shall be the "Cornell Engineer," a magazine published by engineering undergraduates of Cornell University.

Section 2—Each member of the Society, including honorary members and those holding free memberships, shall receive the official publication.

Section 3—The first issue in the fall shall be sent to all those who were members during the previous year.

Section 4—Those paying their dues after the second issue is mailed shall receive only those issues remaining until the end of the year.

Article IX—Membership Lists

Section 1—Six different lists shall be maintained by the Membership Secretary:

A. A list of currently paid members.

B. A list of those whose memberships were paid for the previous year, but not currently.

C. A list of those who have been paid members at some time within five years, but who have not been paid members for the last two years.

D. A list of those whose memberships have been paid in advance.

E. A list of honorary members (including honorary officers.)

F. A list of those new graduates who have accepted free membership.

Section 2—Separate lists shall be maintained of those members affiliated with each Regional Section.

Article X—Membership Certificates

Section 1—Membership certificates shall be of the form prescribed by the Executive Committee, 8" x 10" in size, printed in black with the letters SCE underprinted in red, and shall carry the signatures of the President and the Secretary.

Section 2—Each certificate shall have imprinted upon it the member's full name, and the date of issue. Certificates will not be issued bearing nicknames, but an initial may be substituted for one given name if insisted upon by the member.

Section 3—Degrees granted by Cornell University will be imprinted after the member's name, if requested.

Section 4—Degrees granted by other institutions will be imprinted upon request only if the request is accompanied by satisfactory evidence of the granting of such degree(s).

Section 5—Certificates will be furnished any member upon order accompanied by $1.25.

Article XI—Annual Meeting

Section 1—The annual Meeting of the Society shall be held in the City of New York.

Section 2—The Dean of Engineering at Cornell University is the principal speaker at the annual meeting of the Society.

Section 3—At the Annual Meeting of the Society and at annual meetings of Regional Sections wherever practical, it is the custom to invite accepted candidates for admission to the Engineering College as guests of the Society.

Article XII—Amendments

Section 1—These By-laws may be amended by the Executive Committee at any regular meeting or any special meeting called for the purpose, provided notice of the proposed change is given in the announcement of the meeting.

Section 2—A majority vote of those members of the Executive Committee present and voting shall be sufficient for amendment.

ALUMNI ENGINEERS

Edited by Harry Green III, ChemE '63

Andrew J. McConnell, E.E. '28, was recently elevated to the grade of Fellow in the American Institute of Electrical Engineers for "contributions to design and application of power system protective relays." Mr. McConnell has been active in the AIEE for many years and had served as chairman of the relays committee for two years.

He joined General Electric Company upon graduation and for twelve years, he was a protective-relay design engineer at the Philadelphia works. For the last eighteen years, he has been an application engineer on protective relays in Schenectady. His present title is Senior Engineer, Electric Utility Engineering.

Alumni News

Andrew J. McConnell

Mr. McConnell is the author of over forty technical papers and articles and is the holder of eighteen patents. Besides the AIEE, he is a member of the New York State and national societies of Professional Engineers, the Cornell Society of Engineers, and the Cornell Club of Albany.

Edwin Clinton Towl, C.E. '28, was recently made president of Grumman Aircraft Engineering Corporation. He was one of the six men who founded the company in 1930. In 1937, he was appointed assistant treasurer and three years later, became vice-president and assistant corporate secretary. In 1943, Mr. Towl was named a director of the firm and in 1954, he was chosen as administrative vice-president, the post he held until his new appointment.

Alan B. Mills, Jr., C.E. '36, is senior partner in the architectural and engineering firm of Mills, Petticord, and Mills, of Washington, D.C. The firm was rated last year as the fifty-sixth largest architectural firm in the United States. Mr. Mill is extremely active in community affairs, serving as vice-president of the Washington Building Congress, director of the Boys Club of Washington, and as a member of the Washington Board of Trade, the executive committee of the National Capital Area Council of the Boy Scouts of America, and the Kiwanis Club.

Lewis R. Gaty, E.E. '23, has been elected vice-president in charge of engineering and research of the Philadelphia Electric Company. Mr. Gaty has been in charge of research and development since 1956 and now takes on the additional duties of running the engineering organization. He has also been active in nuclear power development as vice-president of the technical and engineering committee of Atomic Power Development Associates and a member of the technical and engineering committee of Power Reactor Development Company.

Stephen N. Bean, M.E. '31, has assumed new duties as manufacturing manager of the Polaris missile system program, now entering the production stage at Lockheed's Missile and Space Division in California.

Mr. Bean joined Lockheed in 1940 as an industrial engineer working on the P-38 fighter and the Hudson bomber. In 1954, he became chief manufacturing engineer at Lockheed's Georgia Division, and he carried full responsibility for all planning, tool design, tool manufacturing, and plant engineering activities.

He has been active in the Society of Automotive Engineers and Aircraft Industries Association.

Hugh G. Dean, B.S. in A.E. '49, has been named sales manager of the Springfield Boiler Company in Milwaukee, a subsidiary of Cleaver-Brooks Company. In his new position, he will be responsible for the instruction and training of sales agencies, and organizing the sales functions of Springfield's internal staff.

Mr. Dean was formerly Detroit district sales manager for Foster-Wheeler Corporation and has over ten years experience in the sales and engineering of heat exchange equipment. He has particularly broad knowledge in the petroleum, chemical and petro-chemical fields.

Alumni News

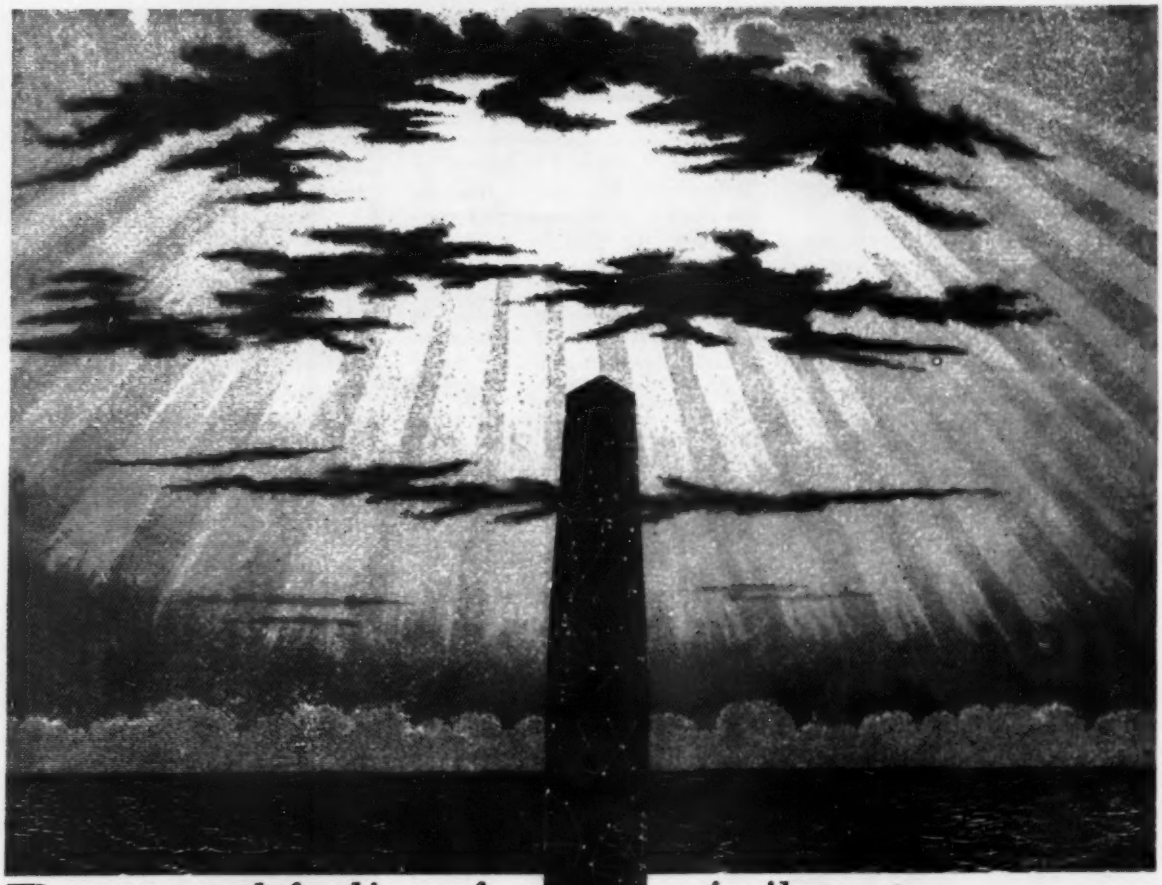
Hugh G. Dean

He is a member of the American Society of Mechanical Engineers, the Society of Naval Architects and Marine Engineers, and the Engineering Society of Detroit.

Raymond C. Baxter, B. Chem. E. '44, was recently appointed Vice-President-Engineering for Allied Chemical's National Aniline Division. In this newly created position, he will be responsible for all National Aniline's engineering and construction activities.

Mr. Baxter joined Allied Chemical in 1946 as a Process Engineer with the Solvay Process Division in Syracuse, New York. He was appointed Assistant Chief Engineer in 1954, and Chief Engineer in 1957. Two years later, in 1959, he was promoted to Assistant Director of Operations.

He is a member of Tau Beta Pi and the American Institute of Chemical Engineers.



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Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

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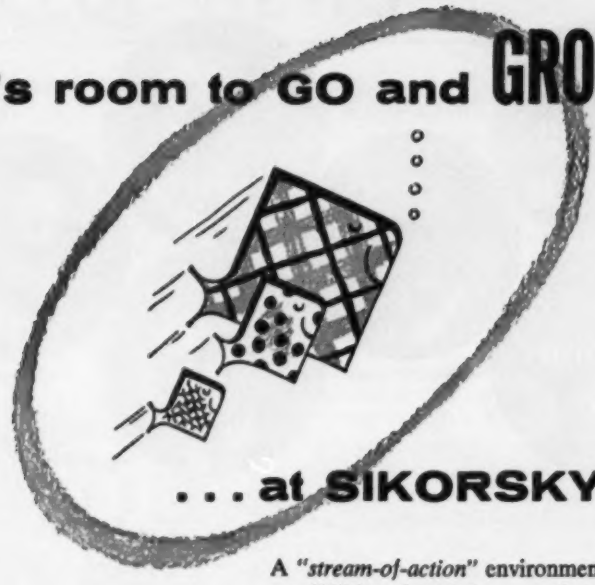

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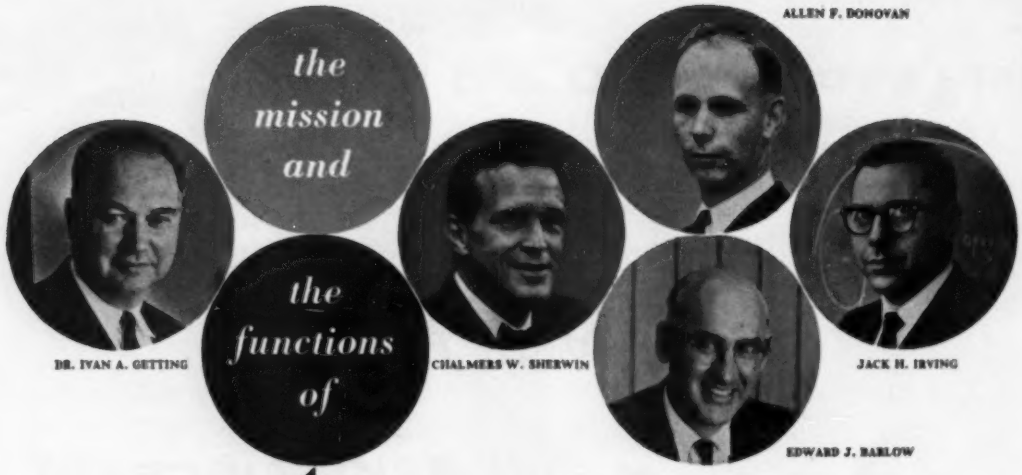

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COLLEGE NEWS

Edited by Joel Lichtenstein EE '64

GRADUATE AWARD MADE TO EE STUDENT

Renewal of a General Dynamics Electronics graduate fellowship in electrical engineering which was established last year, at Cornell, has been announced.

Each of the fellowships carries a stipend of $2400, plus full tuition and all fees. The fellowships will be administered by the Dean of Graduate Studies.

Cornell News Bureau

Joseph W. Douglass, Jr.

The General Dynamics Electronics graduate fellowship in electrical engineering at Cornell University this year is held by Joseph W. Douglass, Jr., of 21265 Kenwood Avenue, Rocky River, Ohio.

PRECISION STEREOPLOTTER INSTALLED IN C.E. SCHOOL

The University recently installed the first high-precision stereoplotter of its kind in a civil engineering school in the United States.

The apparatus, which includes a Wild A7 Autograph and EK–3 Electric Coordinate Printer, makes possible the compilation of more precise maps from aerial photographs, according to Prof. Arthur J. McNair, head of the surveying and photogrammetry department of the School of Civil Engineering.

Designed to work in microns (1/1000th of a millimeter), the stereoplotter is so precise that a random speck of dust or a hair from the operator's head on bearing surfaces would be apparent, Professor McNair said.

One of the stereoplotter's unique features is that it can also be used with tilted aerial photographs as well as photographs taken on the ground, and is capable of extending survey control from photograph to photograph along a strip.

The stereoplotter's new electric coordinate printer enables an operator who observes ground points in the photographs in three dimensions to have three coordinate positions computed and printed merely by pressing a button. Appropriate attachments enable the ground position and elevation above sea level to be put on paper tape or punch-cards – making data ready for subsequent computations with an electronic computer.

Electronic computer map work – a new way of making topographical maps from aerial photographs by using mathematical formulas and electronic computers instead of costly ground surveying – has undergone study and been perfected at Cornell since 1954, under the sponsorship of the U. S. Army Corps of Engineers, the U. S. Navy Photo Interpretation Center, and the U. S. Air Force Aeronautical Chart Plant.

One of the components of the instrument is a precision rectangular coordinatograph. This is used by engineers to plot points rapidly for maps, profiles, grids and graphs with extreme precision.

Coupled with the available facilities of the Cornell Computing Center the precision plotter is an excellent research tool that will make possible the development of new methods according to Professor McNair.

In addition to many applications to mapping and highway engineering, some other fields in which it will prove of value in making studies are geology, forestry, archaeology, satellites and missiles, cadastral and land surveys,

Cornell University News Bureau

New High-Precision Stereoplotter for Cornell University is demonstrated for Cornell faculty members by officials of the Swiss manufacturer, Wild-Heerbrugg, Ltd. Watching the demonstration in the foreground are: (left to right) Sanford S. Atwood, provost of Cornell University; Dale R. Corson, dean of the College of Engineering and professor of engineering physics; Kenneth Reynolds, vice-president of the United States division of Wild-Heerburg, Ltd.; Nephi A. Christensen, director of the School of Civil Engineering; and Arthur J. McNair, professor and director of surveying engineering in the School of Civil Engineering. In the background operating the machine is G. E. Borman of scientific division of the photogrammetric section of Wild-Heerbrugg.

soils, architecture, land planning, and water resources.

The instruction and internal research load will not require the fulltime use of the stereoplotter, Professor McNair pointed out, and it is hoped that Cornell can provide a substantial service to government, commercial and engineering research groups which do not already possess such a precise stereoplotter.

TOTAL RESEARCH GRANTS ANNOUNCED

Cornell University received 50 grants totaling $7,444,868.25 for basic research in the physical and social sciences during the first quarter of the 1960–61 fiscal year (July, August and September).

The grants, awarded by private corporations, foundations, and government agencies, will enable Cornell professors to carry out research ranging from a study of corrosion and embrittlement phenomena in high strength sheet steels used in rocket construction to an investigation and comparison of child training practices carried on by parents in six cultures. The largest grant, $6,100,000, came from the Advanced Research Projects Agency of the Department of Defense to set up at Cornell a vastly enlarged program of basic research in the science of materials.

Among the professors in the Engineering school who have received grants to carry out research projects are:

Vaughn C. Behn, associate professor of sanitary engineering, from the National Institutes of Health for a study of "The Fundamental Rheological Properties of Sewage Sludges."

G. Conrad Dalman, professor of electrical engineering, from the Army Signal Corps for a study of noise generation in microwave oscillators.

Herbert H. Johnson, associate professor of engineering mechanics and materials, from the Navy to study "Environmental Reactions of Rocket Steels" (a study of corrosion and embrittlement phenomena in high strength sheet steels used in construction of rockets).

Harry J. Loberg, director of the Sibley School of Mechanical Engineering, from Babcock and Willcox Company for continuation of studies on heat transfer.

Howard N. McManus Jr., assistant professor of thermal engineering, from the Army for study of "Heat Transfer in Two-Phase Flow Systems."

Lyman G. Parratt, chairman of the Department of Physics, from the Air Force for continuation of X-ray spectroscopic studies of the solid state.

Chester W. Spencer, associate professor of metallurgical engineering, to study "Properties of Semi-Conducting Intermetallic Compounds with Emphasis on the Electrical and Mechanical Properties of the Substances."

Ravindranath Sudan, assistant professor of electrical engineering, from the Rochester Gas and Electric Company, Detroit Edison Company, American Electric Power Service Corporation and Westinghouse Corporation for "Study of Electromagnetic Fields on Ionized Gases."

Herbert F. Wiegandt, professor of chemical engineering, two grants from the Department of Interior for continuation of studies on salt water conversion.

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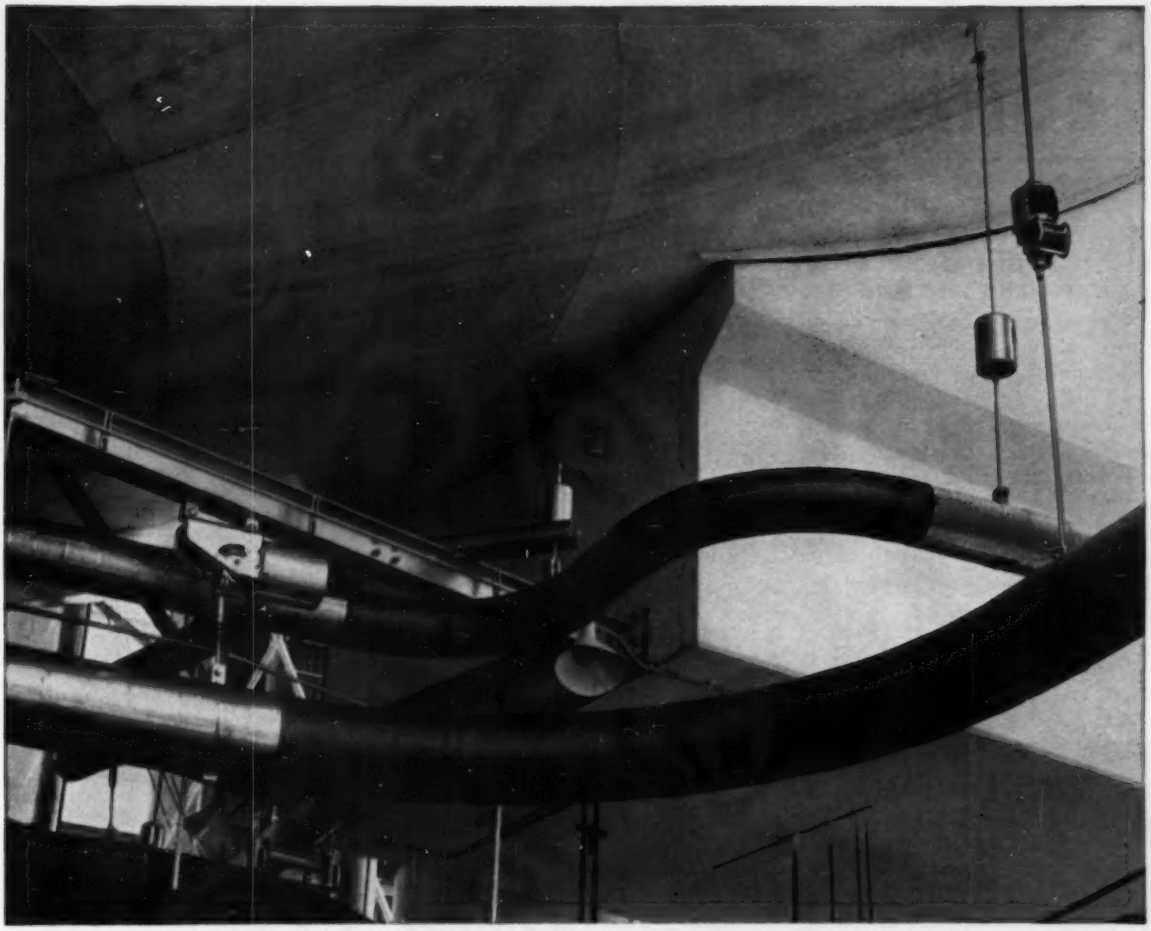

Grinnell Spring Hangers support the pipes carrying steam from the heat exchangers to the turbines.

Grinnell Hangers cradle high-pressure piping at new Yankee Atomic Power Plant

At the new Yankee Atomic Power Plant in Rowe, Mass., uranium fuel in the nuclear reactor keeps the water which flows through the reactor at about 500°F. This pressurized water, at 2,000 pounds per square inch pressure, transfers the heat through piping to a steam generator where steam is produced for running power turbines.

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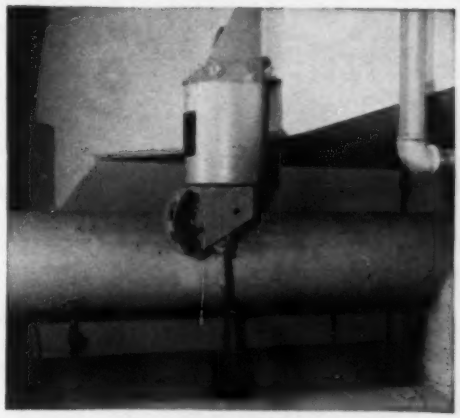

Turbine extraction lead gets support from Grinnell Constant Support Hanger

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Edited by Robert Solomon, EE '64

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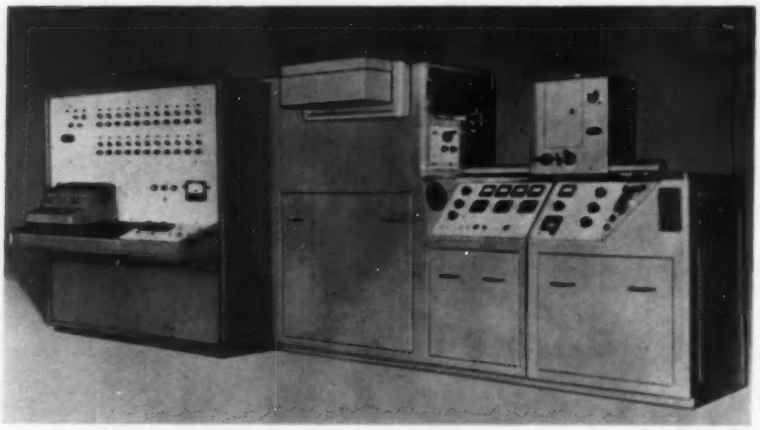


Jarrell-Ash Co.

Typewriter direct reading print-out system developed by Jarrell-Ash Company.

THERMOELECTRIC GENERATORS MADE AVAILABLE FOR INDUSTRY

Westinghouse Electric Corporation is now prepared to design and manufacture a broad line of thermoelectric generators for commercial and industrial applications. Four units, in ratings of 5, 10, 50 and 100 watts, are already available and are typical of the range of devices that can be produced to customer orders.

The generators are completely static and are ideally suited for applications in remote locations. First uses will probably be in cathodic protection of pipelines, valve control, and for powering microwave relay equipment in industrial applications.

Westinghouse is capable of designing units to combine the use of any type of fuel and any type of cooling medium. Gasoline, propane or natural gas are typical fuels, while forced air, water, or natural convection could be used for cooling.

Depending on the application and the type of fuel used, the generators operate at core temperatures between 300 and 600 degrees C. Typical units burning propane gas operate at 400 degrees C.

Recent significant improvements in thermoelectric materials have made the commercial availability of these devices possible. In addition, engineers have developed techniques that permit the construction of better, oxidation resistant thermoelectric couples. All electrical contacts between pellets are either soldered or brazed; the units are free from pressure bonded contacts which are subject to oxidation and lead to deterioration of subsequent generator performance.

The generators basically have low voltage, high current d-c outputs. However, a variety of static inverters or converters can be supplied to provide a d-c or a-c output rating.

ROLLER ROADS PROPOSED AS NEW HIGH-SPEED HIGHWAY CONCEPT

Under a new concept for mass transportation put forward by Westinghouse Electric Corporation, a high-speed electrically driven system of "Roller Roads" would transport groups of automobiles and their occupants at speeds up to 150 miles per hour or commuters at speeds up to 75 miles per hour.

The roadway would consist of a series of rubber rollers spaced approximately 20 feet apart to resemble inverted roller skates. Powered by individual motors, these rollers would both support and propel the flat-bottomed carriers in which automobiles and passengers would travel.

The basic principles of the new system are:

The conveyances which carry automobiles will be devoid of all apparatus whose failure might cause a highway shutdown or delay; each lane of the highway will be a continuous, computer-controlled system of individually powered rollers, receiving electric energy from neighboring interconnected electric utility systems. This roller system will not only be the highway surface, but will accelerate the conveyances, keep them moving once accelerated, and provide braking power at proper locations; the conveyances will be stopped at fixed stations where the automobiles will be loaded and unloaded automatically to achieve uniform loading in minimum time.

Each carrier would be approximately 110 feet long. Provision would be made for 10 automobiles plus a lounge with rest room facilities. The carriers would be operated in strings of 3 to 10 units under normal conditions. The only

factor limiting the number of carriers would be the length of the loading platforms.

Guide wheels operating against the rails at either side of the Roller Road would steer the carriers along the rollers. As the only rotating devices on the carriers, these wheels could also be used to power generators to supply light and heat inside the carriers.

The drive package for each roller would consist of a three-phase induction motor, a torque converter, a brake, and a reduction gear. The time required for a 1100-foot string of 10 carriers to pass over a given roller at 150 mph is about 5 seconds. Consequently these motors would work for five seconds and then would idle until the next conveyance came along. The motors thus could be heavily "overloaded" for short peak intervals, greatly reducing their size. The mechanical brake would be included on each roller, to provide for emergency stops anywhere along the highway.

A loading and unloading time of one minute was set as a goal in order to maintain an average speed of 120 miles per hour over the highways. Drivers intending to board a carrier would place their cars on dollies at platforms adjacent to the highway. This would be the last action required of the driver until he and his car were automatically unloaded at his destination.

Computer-controlled lights would indicate to a driver which spaces were empty on the approaching carrier. When the carriers stop, automatic devices attached to the station platform raise the proper doors on each side of the carriers. With the doors raised, a mechanical device would push the dolly and the car onto the carrier. The corresponding dolly on the carrier, whether or not it carries an automobile, is pushed off the carrier on to the other side of the platform.

Consideration was given to the possibility of people driving automobiles on and off the carriers but was discarded because of the uncertainties of human behavior. The computer control for the system would dispatch strings of carriers at proper intervals; provide protection against rear-end collisions should any string of carriers be stopped; control the automatic loading and unloading at stations.

Basic advantages of this system would be:

It can handle conventional toll road traffic at twice the speed. Its capacity could be increased with little expense by running more than 10 carriers together as an operating unit. It could carry high-class freight in containers at speeds comparable to the airlines. It is an all-weather route, invulnerable to delays from fog, ice, sleet or snow. It can carry passengers who may desire to travel without their automobiles at high speeds. The same principles could be applied to produce an excellent rapid transit system for large urban communities such as San Francisco, Los Angeles or Pittsburgh.

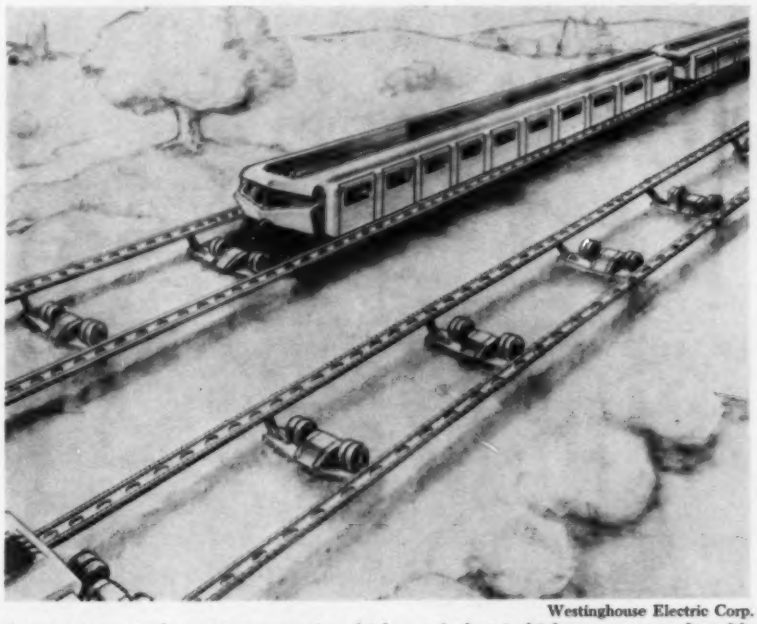
ADVANCE IN AUTOMOTIVE DESIGNING: THE ALUMINUM ENGINE

A six-cylinder engine with an aluminum block is now available in the 1961 compact Dodge Lancer. The new cylinder block is die-cast, and is offered only with the 145-horsepower, 225-cubic-inch six-cylinder engine. The aluminum block reduces the weight of the engine by almost 65 pounds. A six-cylinder engine with cast-iron block weighs 413 pounds.

Advantages of the lighter engine are that the load on front wheels is reduced, steering requires less effort, braking loads are decreased and even the wear on tires is reduced.

The engine is machined and assembled on an auxiliary production line. Cylinder blocks are supplied by the Corporation's die-cast plant in Kokomo, Ind. This plant, in existence for 3½ years now, is currently producing over 60 different die-cast aluminum components for engines and transmissions. An additional 18,000 square feet of floor space has been allocated at the plant to house seven new die-casting machines producing aluminum blocks. These machines, each having a die-locking force greater than 2,000 tons, are among the largest of their kind used in the industry. A high standard of performance and reliability has been assured for the aluminum engine, by an intensive test program.

More than 100 prototype engines installed in regular passen-



Westinghouse Electric Corp.

A new concept of mass transportation; high-speed electric highway system adaptable either for automobiles or rapid transit commuters. The carriers rest on and are propelled by a series of rollers shown above. The two rails serve to guide the carriers along rollers. Described as a Roller Road by Westinghouse, the system would move automobiles and their occupants at speeds up to 150 miles per hour, and commuters at speeds up to 75 miles per hour.

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ger cars have logged more than a million miles of rugged road testing, proving the engine's capabilities and endurance under all operating conditions. In addition, 15,000 hours of endurance cycling have been amassed on engine testing dynamometers in the laboratory.

Dodge's aluminum cylinder block is specifically designed to be die-cast. The technical and economic benefits of the die-casting process are well known, and are so substantial, that numerous manufacturers are expected to switch from permanent mold methods to die-casting in the future. Die-casting provides a more accurate and consistent product than previously used mold techniques. It offers better casting quality because of accurately controlled casting temperatures and pressures, and highly automated inspection methods.

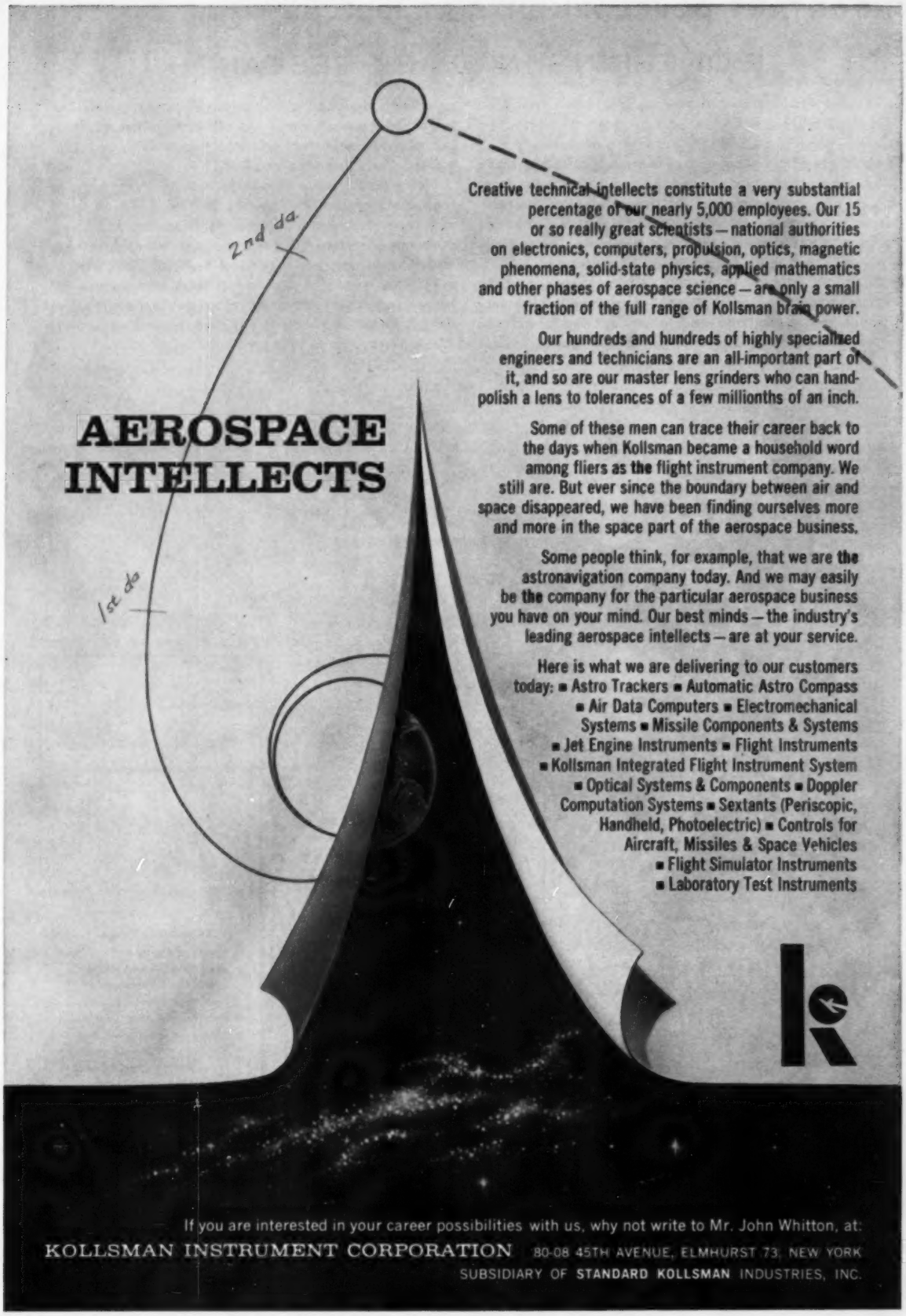
By using die-casting, the aluminum block can be designed to combine optimum structural strength and rigidity with minimum metal usage.

Use of metal dies and high casting pressures permits minimum wall thicknesses and more uniform sections. This contrasts with the sandcasting process where heavier sections are required. Die-casting also is considered a superior process for mass production, being faster and more economical. Machining requirements are reduced, tools last longer, and production rate is increased.

The Lancer's cylinder block has integrally-cast dry cylinder bore liners of cast iron, cast-iron upper and lower main bearing caps, and a special composite cylinder head gasket. Extensive research and testing was required to refine the design with respect to cylinder wall wear, crankshaft bearing clearance control, sealing, casting stress and operating stresses.

The design of the block takes full advantage of the high standards of quality control which die-casting permits.

The most significant advantages of the aluminum engine are that it reduces the vehicle weight, eases the steering, and allows better gasoline economy and car performance.



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JPL will conduct the missions, utilizing these spacecraft to orbit and land on the moon, to probe interplanetary space, and to orbit and land on the near and far planets.

Earliest of these spacecraft will be the "Ranger" series now being designed, developed and tested at JPL. The mission of this particular series will include first, exploration of the environment and later the landing of instrumented capsules on the moon.

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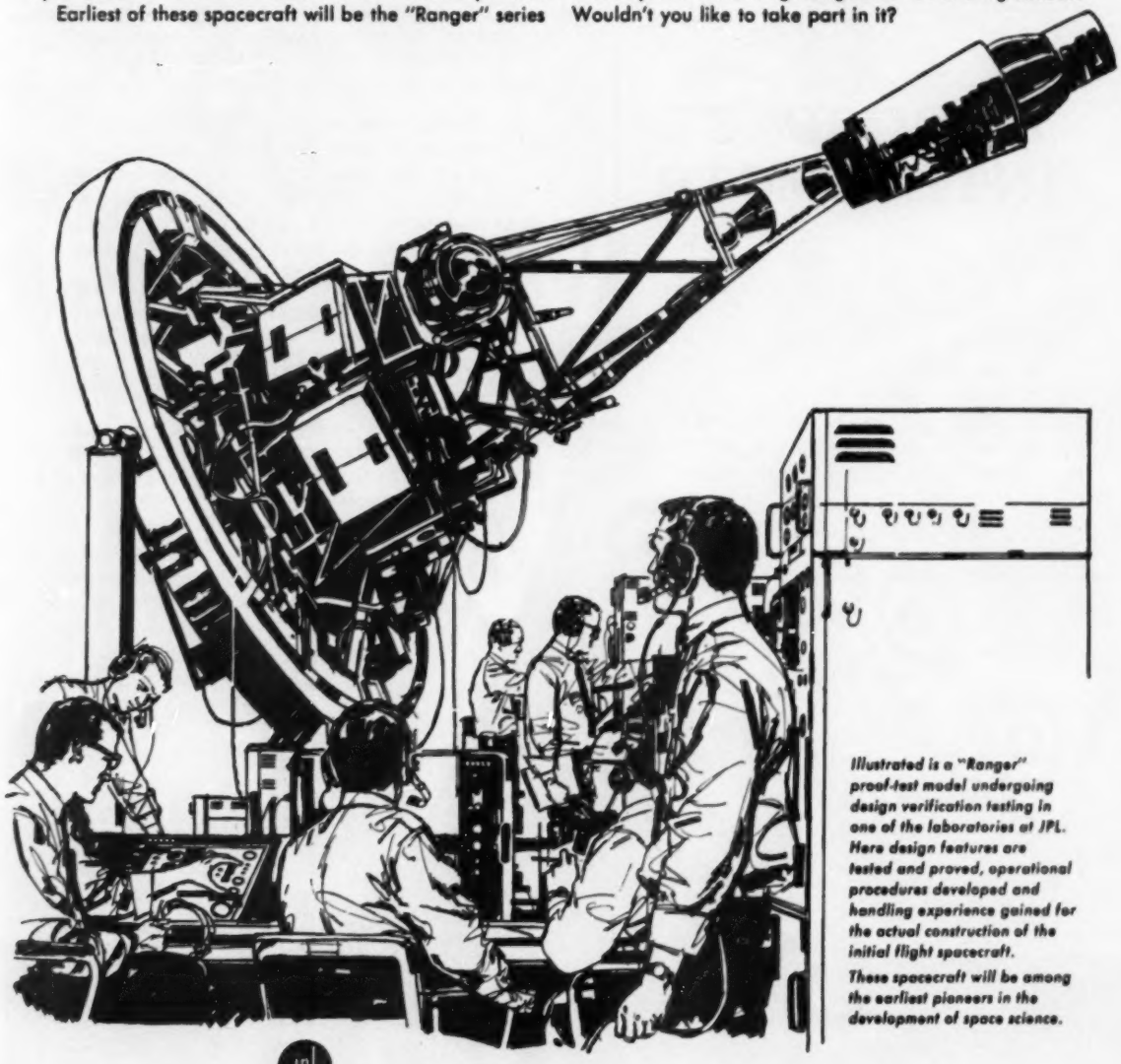

Illustrated is a "Ranger" proof-test model undergoing design verification testing in one of the laboratories at JPL. Here design features are tested and proved, operational procedures developed and handling experience gained for the actual construction of the initial flight spacecraft.

These spacecraft will be among the earliest pioneers in the development of space science.

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FIFTY YEARS AGO IN THE ENGINEER

Edited by Robert Stern, EE '63

With the introduction of high speed heavy duty electric traction, the need for a high voltage continuous current motor was felt. Under certain conditions it is impossible to use the ordinary urban and suburban pressures of 500 or 650 volts on account of the cost due to size of conductors and the drop of voltage to say nothing of the dimension of the apparatus and motors themselves.

The Siemans-Schuckerwerke, G.m.b.h., of Berlin, Germany, have undertaken the construction of motors for DC pressures up to 2000 volts. The motors differ from ordinary railway motors only in having the windings and commutator specially insulated and in possessing commutator poles. The normal speed of the motor at its full rated HP is 850 rpm. The efficiency of the motor is approximately 83% and weight without gear wheels or gear case is 850 Kg. (870 lbs.).

The motor frame is built of soft cast steel and has an approximately octagonal form. The general design is the same as the latest railway practice, that is, it is divided into two parts horizontally so that the commutator, armature, and field coils can be inspected in the usual way.

The poleshoes are built of insulated plates securely bolted together and fixed to the frame by strong screws. The armature is built of laminated iron, insulated with paper and slotted for the winding. The form wound coils are fixed in the slots of the armature by wooden wedges which make the repairs much easier than they are when the coils are fastened in with bands. The eddy currents in the bands are at the same time avoided.

On the test floor, the motor was found to run entirely sparkless when developing 22 HP at a terminal voltage of 1500 volts. It was also found possible to raise the pressure to 2000 volts without the slightest trace of sparking at the commutator.—*Sibley Journal, 1911.*

A. H. Crist, '91, of the Arthur H. Crist Co., publishers, of Cooperstown, N.Y., would like to get in touch with a graduate of the Electrical Engineering Department, having at least two years outside experience, to specialize in electrical work and internal combustion engines. Salary at start, $700 to $800 a year.

—*Sibley Journal, 1911*

Dr. Steinmetz, the next speaker, declared that the engineering profession has today become the most indispensable of all the professions. It would be impossible for the human race to exist in such great numbers without the aid of the engineer. In future years, as the natural resources of the earth gradually fail, this need will grow more and more insistent, and the field of the engineer will ever be increasing. Dr. Steinmetz then outlined his conception of the ideal engineer: one who could properly fulfill the stringent requirements of his profession. In the beginning, the technical student should devote himself while in college more particularly to the theoretical side of engineering, leaving the practical side to be learned later. After graduation, opportunities for obtaining practical experience are unlimited, but if the theoretical foundation has not been built up during the college course, it becomes too late to remedy the fault after entering the engineering field. There will be little or no time available for study and no one to aid and instruct. Moreover, the training of the ideal engineer should not be confined to technical matters alone. It should be broad enough to enable the engineer to deal successfully with men of all types, for the engineer must primarily be a natural leader and director of men. Today, the engineer, because of insufficient training in business and politics, is usually subservient to the man who has no abilities as a producer but who has devoted his whole energies toward becoming an organizer and a leader. [From the annual Sibley Banquet.]

—*Sibley Journal, 1911.*

The Roosevelt Dam, Salt River Irrigation Project, Arizona, will be formally opened on March 18 with ex-President Theodore Roosevelt as guest of honor, says Engineering News. The last stone in the parapet walls and the dam was laid at noon, February fifth. The dam has a total height of 284 feet from foundation to parapet and a top length of 1,080 feet. A twenty foot roadway extends along the top of the dam. The reservoir formed by the dam has a length of twenty-five miles, a maximum depth of over 200 feet and an approximate capacity of 56,628,000,000 cu. ft. The water stored by the dam will be used in irrigating some 200,000 acres of land near Phoenix. In addition, hydro-electric power will be developed at the dam site, and used for pumping underground water to irrigate 60,000 acres of land located about 100 miles down the valley.

—*Sibley Journal, 1911*

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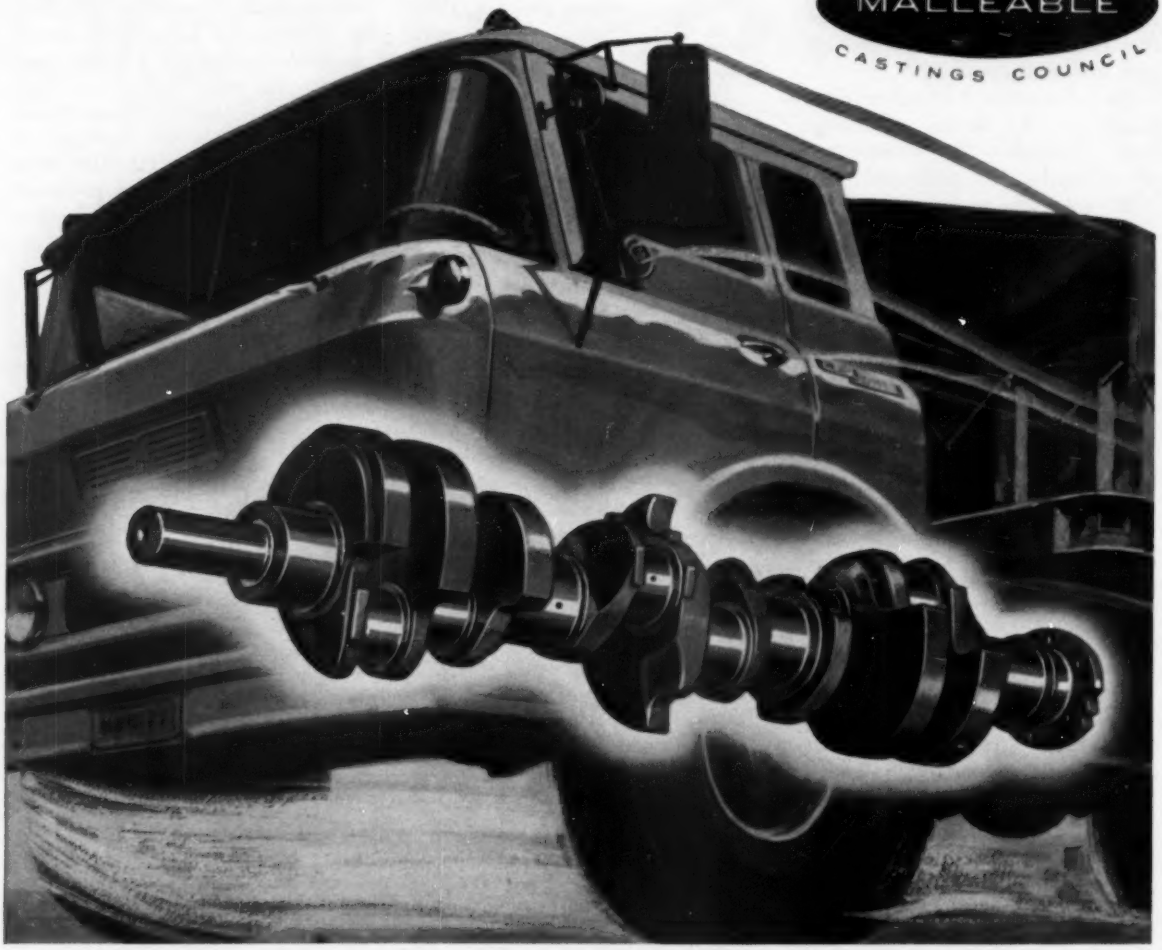

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STRESS *and* STRAIN . . .

Edited by William D. Nickles Jr., EE '65

"I 'aven't 'ad a bite for three days," said the tramp to the landlady of an English inn, *George and the Dragon*. "Do you think you could spare me one?"

"Certainly not," replied the landlady, slamming the door in his face.

A few minutes later there was a knock on the door. She opened it and the same tramp was there. "What do you want now?" she asked.

"Could I please speak to George?" said the tramp.

• • •

"Thish match won't light."

"Washa matter with it?"

"I dunno — it lit all right a minute ago."

• • •

Two men were sitting in a bar. "Albert," asked one, "after you drink a lot, does your tongue burn?"

"I don't know, Sam," replied the other. "I've never been drunk enough to light it."

• • •

Owner: "How did you come to puncture this tire?"

Chauffeur: "Ran over a milk bottle."

Owner: "Didn't you see it in time?"

Chauffeur: "No, the kid had it under his coat."

• • •

"How can you keep eating this dorm food?"

"Oh, it's easy. I just take a tablespoon of Drano three times a day."

• • •

ME Test Problem:

A crosseyed woodpecker with a cork leg and synthetic rubber bill required one-half hour to peck one-fourth of the distance through a cypress log 53 years old. Shingles cost 79 cents per hundred and weigh eight pounds apiece. The log being pecked upon is 34 feet long and weighs 46 pounds per foot. Assuming that the coefficient of friction between the woodpecker's bill and the cypress log is 0.047 and there is negligible resistance to diffusion, how many units of vitamin B_1 will the woodpecker require in pecking out enough shingles for a $75,000 barn with detachable chicken house? The woodpecker has an efficiency of 97% and gets time and a half for overtime.

• • •

The crystal-gazer who collected $25 for a reading informed her visitor, "My fee entitles you to ask me two questions."

"Isn't that a lot of money for only two questions?" the startled sitter queried.

"Yes, madam, it is," answered the fortuneteller gravely. "And now, what is your second question?"

• • •

With TV and picture magazines being so popular, if it wasn't for alphabet soup most people would give up reading entirely.

• • •

Economics lesson for today: Girls without principle draw considerable interest.

• • •

It was New Year's Eve. A Salvation Army lassie was standing on the corner testifying. "I was a sinner," she said, "who flitted from dance hall to dance hall. I drank liquor every night. I smoked constantly. I did everything bad. But I was saved, and now I don't dance, I don't drink, I don't smoke, I don't sin any more at all. In fact, I don't do a darn thing but hang around here and beat this lousy drum."

• • •

The football coach, dejected because his team was losing, looked down the bench of substitutes and yelled: "All right Jones, go in there and get ferocious."

Jones leaped up and answered: "O.K. Coach. What's his number?"

• • •

The preacher at the close of his sermon discovered one of his deacons asleep. To teach a little lesson he announced, "We will now have a few minutes of prayer. Deacon Brown will lead."

"Lead?" said Deacon Brown suddenly awaking, "I just dealt."

• • •

Some years ago when the Cornell football team was playing Army at West Point, the game was hard fought and a number of penalties were called, most of them against Cornell. Sitting directly back of us were four coeds, who did not take kindly to these Cornell setbacks. After one 15-yard penalty, a coed demanded, "What's it for this time?"

"Illegal use of hands," I told her.

"Wouldn't you know it?" she cried. "That's Cornell for you everytime!"

• • •

A few years ago Uranium cost two dollars a ton. Then someone found out it could kill people.

• • •

Two first graders stood talking in the school playground during recess when a jet plane flew over. "Look at that," said one, "it's an XB-50."

"No, an XB-51," commented the other. "You can tell by its wing sweep."

"You're right," conceded the first youngster. "But it's not going more than 760 miles per hour because it didn't break the sound barrier."

The second lad agreed on this point and remarked, "It's amazing the pressure that develops on those planes when they go into a dive — almost 1200 pounds per square inch."

Then the school bell rang indicating the end of recess and the first boy sighed, "Let's go back in and finish stringing those darn beads."

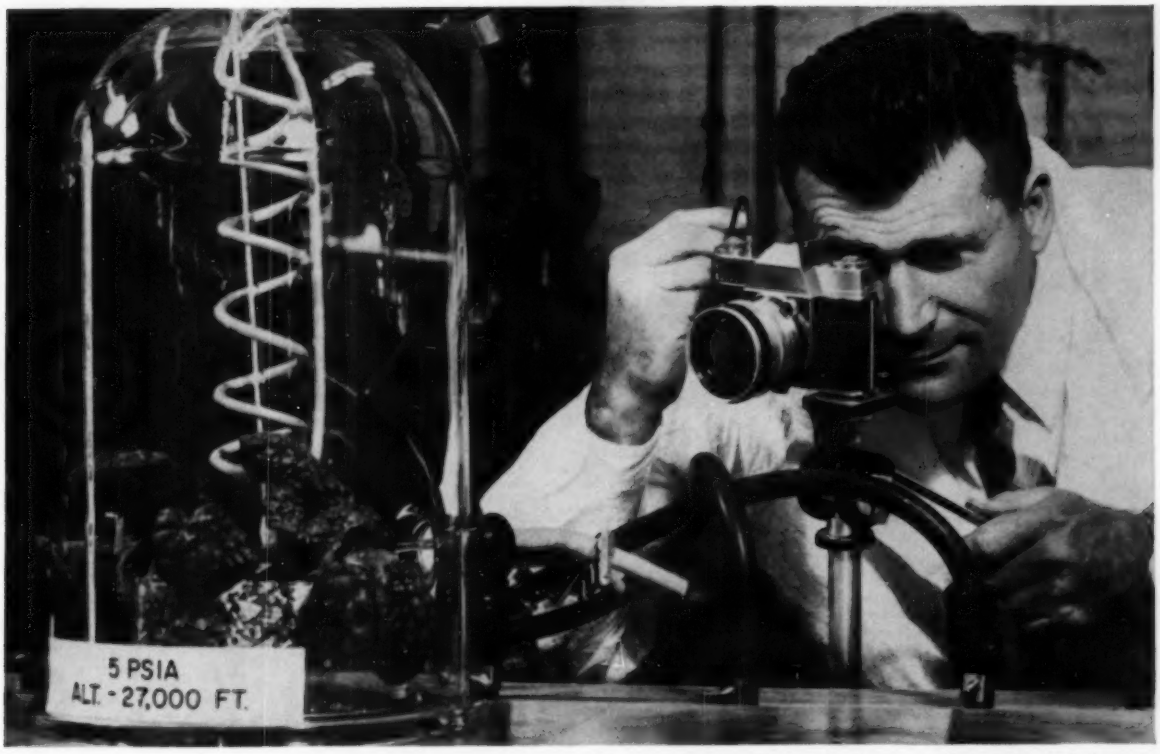
• • •

Captain: "Why didn't you salute me yesterday?"

ROTC Recruit: "I didn't see you, sir."

Captain: "Oh, all right then. I was afraid you were mad at me."

If your sights are set on space survival–



Scientist photographs the development of experimental "lunar" plant at the Republic Aviation Corporation's "Lunar Garden."

–you'll find **Photography at Work** with you

Solving the problems of a human being living in outer space has become the task of scores of engineers, chemists and botanists. And serving them as a valuable working tool is photography. It records the growth of experimental plants and fungi that can well become the space voyager's food supply. Through autoradiography it can show the absorption of cosmic radioactive material, trace its circulation within the organism.

There's hardly a field on which you can set your sights where photography does not play a part in advancing work and simplifying routine. It saves time and expense in research, on the production line, in the engineering and sales departments, and in the office.

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TRADE MARK

One of a series

Interview with
General Electric's Byron A. Case
Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have over 5 years experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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